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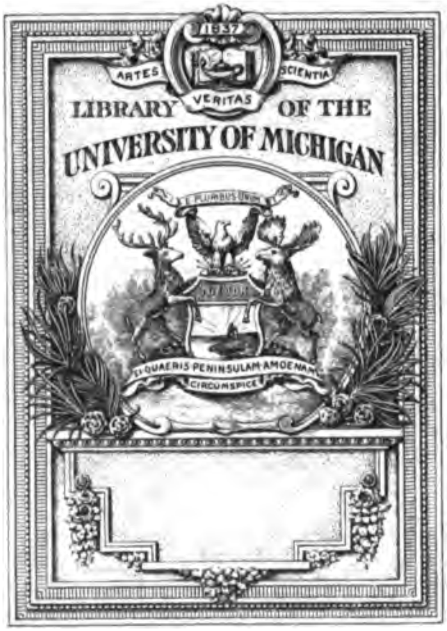

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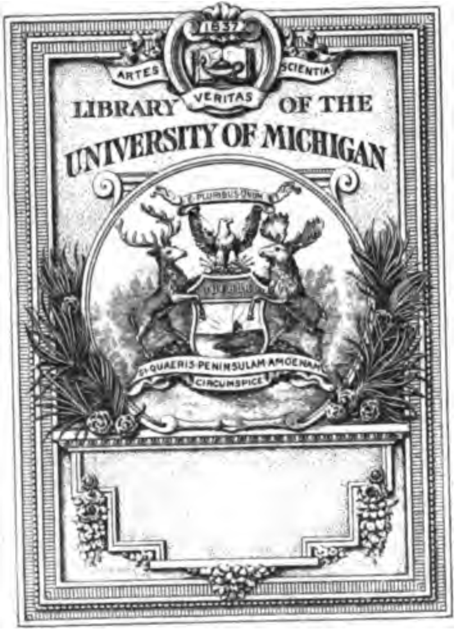
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ASPECTS OF MENTAL ECONOMY

AN ESSAY IN SOME PHASES OF THE DYNAMICS OF MIND, WITH PARTICULAR OBSERVATIONS UPON STUDENT LIFE IN THE UNIVERSITY OF WISCONSIN

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CONTENTS.

INTRODUCTION.

CHAPTER I.

THE RELATION OF MIND AND BODY — AN ENERGEIC CONCEPTION.

§ 1. An Historical View 44
2. The View of Experimental Science 46
3. Neural Fatigue: Its Nature and Motor Effects 50
4. Neural Fatigue: Intellectual Effects 55
5. Neural Fatigue: Emotional Effects 60

CHAPTER II.

CEREBRAL HYGIENE AND ECONOMY IN STUDENT LIFE.

§ 1. The Student's Obligations to the State 64
2. The Study of Psychical Processes,— Dangers, Advantages... 65
3. The Educator's Concern with Cerebral Hygiene 67
4. Studies at the University of Wisconsin: Purpose and Methods 68

CHAPTER III.

RELATIVE VALUE OF FOODS IN THE PRODUCTION OF NERVOUS ENERGY.

§ 1. The Philosophy of Nutrition 73
2. Statistical Summary of Studies on Foods 78
3. Composition of the Food Stuffs Found in the Tables 82
4. Composition and Value of Food Materials not Found in the Dietary Lists 86
5. The Nutrient Value of Students' Dietaries,— Estimates and Comments 90
6. Specimen Dietaries Fulfilling the Requirements of Adequate Nutrition 101

CHAPTER IV.

RELATIVE VALUE OF FOODS IN THE PRODUCTION OF NERVOUS ENERGY (continued).

§ 1. Condiments as Force-producers 107
2. The Influence of Tea, Coffee, and Cocoa upon the Production and Expenditure of Force in the Organism 108
3. The Influence of Alcohol in Wine, Beer and Other Beverages in the Production and Expenditure of Force 115
4. The Influence of Tobacco upon the Production and Expenditure of Force in the Organism 123

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CHAPTER V.

THE PREPARATION OF FOOD — HOURS FOR MEALS.

§ 1. The Philosophy of Cookery 126
2. Modes of Cooking,—Local Practices with Criticisms......... 128
3. Hours for Meals 134

CHAPTER VI.

INDIVIDUAL PECULIARITIES IN DIGESTIVE CAPACITIES.

§ 1. The Theory of Individual Differences........................ 139
2. Concrete Examples 140

CHAPTER VII.

EXPENSE OF DIETARIES.

§ 1. Taste vs. Expense in the Choice of Foods.................... 145
2. The Cost of a Dietary of Different Foods 146
3. Local Expenses, with Practical Suggestions 149

CHAPTER VIII.

FRESH AIR, EXERCISE, AND REST IN THE PRODUCTION AND EXPENDITURE OF CEREBRAL ENERGY.

§ 1. Function of Oxygen in the Organism 153
2. Exercise 156
3. Sleep 163

CHAPTER IX.

THE CONSERVATION OF ENERGY.

§ 1. Wasteful Muscular Tensions.................................. 170
2. The Daily Program.. 187
3. "Tell me what company you keep, and I will tell you what you are".. 196

ASPECTS OF MENTAL ECONOMY.

INTRODUCTORY.

In this essay I have ventured to discuss from a particular point of view the question, How can a student make the most of himself? In one or another of its aspects this matter is considered alike by religion, by psychology, by ethics, by education, by hygiene, and by other philosophies and sciences. Each regarding a special phase of man's being seeks to advise him concerning his conduct so that he may attain the highest possibilities of his nature. Thus, religion counsels him respecting the deportment which will prepare him for habitation in another world; ethics aims to so determine his demeanor that he may dwell in the spirit of justice with his fellowmen; education delineates the processes by which he may secure the fullest development of intellect and character. The phase of this large subject which is discussed herein is indeed a narrow but yet, I believe, an exceedingly consequential one. Taking a doctrine accepted by modern science, that, looked at in a certain light, a human being is seen to be a machine fashioned to do a given amount of work, depending upon the quantity of energy which may be utilized for this purpose, I have sought to examine the ways in which this energy can be most readily generated and wisely conserved so that it may be employed in profitable production of either a mental or physical sort.

The view-point I have taken is what might perhaps be called an energeic[1] one. If this should sound too materialistic to some readers they will certainly not be aggrieved when they consider that there has been no attempt to examine the entire nature of an individual. No one could imagine that the only problem involved in a person's success in life relates to the generating and conserving of nervous force. This is surely important enough, but yet more important things follow. When one is in possession of his forces then the question arises, what shall he do with them? In what direction shall he expend them? What is really worth while? The answers to these queries must be sought for in the principles of religion, education, and allied departments of knowledge concerning human life.

---

[1] I coin this word to express precisely a certain relationship of mind and body which is discussed at length in the course of the essay.

I am well aware that I have discussed in an inconclusive manner some topics connected with my subject. Indeed, certain problems have been simply opened up for more detailed consideration later rather than settled in any satisfactory way. This is made necessary at the present time by the unbroken character of the field. So far as I know there has as yet been little serious effort to discuss deportment from an energeic point of view, and in a comprehensive, systematic form. All that has been done is of an isolated, fragmentary character, and most of the available data concern more or less simple processes which are likely to have their properties much modified when combined into the complex thing we call conduct. These data are scattered through a number of sciences; and what I have attempted to do is to gather up the most relevant of them and interpret them in the light of one another, and by the aid of observation and experience, keeping constantly in mind local practices and conditions. I regret that it has not been possible to investigate in a more thorough manner several of the matters treated; but if those who feel the lack of certainty will be stimulated to undertake detailed and exact studies for themselves, some good will have been done. I am convinced, though, (and this is a source of consolation), that for practical purposes it is often quite as efficient to direct an individual's attention to the consideration of a certain line of conduct as to presume to give him explicit directions respecting his actions.

It may occur to some that this subject is as a whole an extremely large and complicated one to be treated according to scientific methods. They may feel conduct consists of such a bewildering complexity of factors operating together that it is for the present impossible to handle it with that precision which is the *sine qua non* of scientific procedure. Science in our day is minutely analytic, dissective; it seeks to single out from habitual associates particular factors or phenomena and investigate their properties. It attaches relatively little value to investigation which cannot control the conditions accompanying a phenomenon to be studied; for when we take a thing in the large, when we cannot separate it from its *milieu,* so to speak, it is not easy to see what elements are really most active in determining its nature. But now so far as psychological experiment is concerned, it is utterly impossible by any known methods of investigation to cut off elementary psychical processes wholly from each other. Experimental psychology may attempt to investigate an isolated sensation, for instance; but such a thing is a pure abstraction. In the intricacy of the psychic organism one element never can be entrapped apart from others with which it has become inseparably associated through experiences no less in phylogenesis than in ontogenesis. The most that can be done is to limit the run, as it were, to hedge it in on every side; to have, that is to say, as few factors as may be entering into a problem. The results of the most accurate experiments then in the mental sciences are only relatively more exact than those of observation or experience. It may be permissible to point out in passing that in our time there is some danger of experimental psychology conveying the impression that it is more precise than it ever can be. In a considerable part of present-day scientific writings one is led to think that the most primary phenomena have been examined with mathematical accuracy, when as a matter of fact there must have been left out of account accompanying conditions which determined to a greater or less extent the behavior of the thing studied.

While in general the analytic method of experimental science is to be highly commended, still in some situations it is probable that more satisfactory results can be attained by studying a thing in the large than in its elements,—macroscopically rather than microscopically. The French school of psychologists, following the lead of Binet and Henri, maintain that more of genuine worth for science is gained by examining an individual human mind in its totality, so to speak, than in its elements; while the German school, represented notably by Kraeplin, take an opposite view,—that reliable results can be secured only by a study of the most elementary processes in different minds. The one studies the living, complex entity, the other dissects and examines relatively simple factors. The movement in our own country seems just now to be headed in the direction of the French rather than of the German school. At all events, it should be apparent that we can apprehend, and that truthfully, characteristics in an organism when various forces work together that we would miss if we concentrated our attention solely upon each separate factor. These latter are not differentiated enough, it may be, to claim our attention; it is only when a vast number of them co-operate, when their properties are pooled, so to speak, and we have a personality, that we discern the significance of their total influence.

So in the study of conduct there are certain advantages in viewing a person as a whole, as an entity whose distinctive attributes are not apparent in each primary factor of mind or body. And this may be done with something like scientific precision. To illustrate, I may describe with accuracy the conduct of a drunken man without investigating in detail the simple physical and mental processes which totalized beget the state of inebriation. If I see clearly and tell truthfully my story may be relied upon. So one may set forth the effects of certain modes of living upon the energies of the organism without studying the most elementary phenomena involved in the total process. A fact observed, whether it relate to exceedingly complex or markedly simple objects, is in any event a fact and as such is worthy of our credence. Thus history may be considered to treat of the utmost conceivable complexity of subjects which, in their extremest analyzable form, are considered by neurology and analytic psychology. But the principles of history are not on this account to be regarded as less trustworthy than those of neurology. Microscopic study, just because of its minuteness, is not more reliable and trustworthy than macroscopic study; you can describe as well (and it may be better) the conduct of a horse as that of an amoeba. That it may be valid though, of course your description must be verifiable alike by experience and by experimental research *ad libitum;* but so long as it stands the test it must be accorded all the honors and privileges of scientific knowledge.

I know it is a hazardous thing to express an opinion upon matters respecting which every one is an authority. And if there is one matter more than another which needs no study to comprehend, it is that which has to do with the regulation of our daily lives. Here common-sense, elsewhere so little trusted, is esteemed a wise guide. It is one of the simplest principles of psychology that we all tend to make our thoughts and actions standards by which to estimate their own value. It is difficult for me to believe that the factors which have produced me are beyond improvement; what I do must be right. Every one entertains Phantoms of the Cave when such familiar things are under inspection; and this it is which makes it so hard to convince people that they should ever modify their conduct. But it ought to require no argument to prove that the self-standard in deportment is no standard at all. Because I have been living in a certain manner and have survived is no evidence that I could not have lived better by adopting a different régime.

A woman was recently discussing the subject of food, and contended that modern scientific investigation was valueless if not detrimental in promoting happiness in life. She had brought up a family in violation of all the rules of hygiene respecting diet, and she instanced her six grown sons and daughters to prove that hale and hearty children could be reared on "unhygienic victuals." As a matter of fact, however, these "stalwart" men and women are taking medicine half the time; and not one of them has yet accomplished anything of consequence in the world. But this woman, beholding them through a mother's eye, is convinced that perfection has been attained in their construction; while a disinterested neighbor sees the matter in a quite different light. It is a far cry from the grave to the most energetic and efficient living; and because one is alive is no evidence that he could not be more alive. It is not assured beyond question that one out of jail is a good citizen; nor is it at all conclusive that because one is "getting on" in the world he could not swing along with greater momentum by the aid of a knowledge of some of the principles of mental mechanics. It would indeed be a remarkable circumstance if by accident alone we should have hit upon the very best ways of ordering the minutæ of our daily lives, when it is seen how great advances, what discoveries of beneficial methods are made by careful study in other fields. If science can do so much for us in simple matters how much more ought it to help us in the most complex and intricate of all affairs,—the adjustment in harmonious relations of a human being to his environments. But the very complexity overwhelms the common mind, stops up the avenues of thought, and it falls back on the universal platitude of ignorance, "Oh! there's nothing in it anyway."

On the other hand, one too conscious of his demeanor in respect of the petty details of life is in so far limited in his efficiency. A mind turning in always upon itself or upon bodily processes throws the machinery of life out of gear. Speaking in general terms that mind is the best instrument that is concerned with objects outside of self, when the organism adjusts itself to the attainment of these ends; then things work together in harmony. This is the ideal. But yet through early ignorance or through the necessity of adaptation to wasteful conditions in our environments we may fall into practices that lessen the efficiency of our forces. By a little thought these prodigal habits may be supplanted by better ones, when the mind may again be free. Now, the requirements of mental hygiene do not demand one to be constantly dwelling upon his actions; they simply ask him to exchange certain not too deep seated habits by others, and to make these latter automatic as soon as possible. In the matter of producing energy, those who have charge of our dietaries and our living apartments are the ones who should become conscious of our needs; and if landlords and club managers were only experts in their business and could supply us according to our necessities, we should then be relieved from attending to such matters for ourselves, and greatly to our advantage. But as the situation exists in our midst it seems needful that those who suffer should search out their own remedy; and it is to be hoped that this will not breed too great consciousness respecting in a way trivial matters, but only that it may serve to bring about certain simple modifications in diet and living which will soon fall into the regions of habitual and subconscious action.

CHAPTER I.

THE RELATION OF MIND AND BODY.—AN ENERGEIC CONCEPTION.

§1. *An Historical View.*—From the earliest times men have debated over the connection between the physical and the mental in the human organism. This has been the problem of chiefest concern, at various stages in the development of thought, alike for mythology, for religion, for philosophy, and in our own era for experimental science. The conception of mind most characteristic of primitive reflection in the individual as in the race regards it as a tenant of the body ruling over and directing its activities, and being influenced itself in some measure, great or small, by bodily conditions, and what may be called physical or outward demeanor. This notion does not postulate any organic relationship between, much less identity of, mind and body. There is but a sort of tangential relation, so to speak; and the spirit can if it will free itself wholly from the control of the material structure in which it is momentarily entombed. It is only when the volitional element in one's being is lethargic that he yields to the promptings or suggestions of his physical self, which, most unhappily, are natively of an evil mien. Holding this view men believed during long epochs in human history that they ought to scourge and maltreat the body that they might thus purify and strengthen the spirit; for if the animal be not held under subjection by such discipline it will endanger the supremacy of the man: a doctrine quite contrasted to the theories of these latter days, when it is proclaimed on every hand that the more respect we pay the body, and the kindlier and more faithfully we attend its needs the greater will be the reward in spiritual exaltation and freedom.

Correspondent with the development of physical science in its earlier years, however, there gradually arose another and a vitally different theory,—that in an ultimate analysis mind can be reduced to material terms. This conception becomes easily established in the evolution alike of the racial and of the individual mind, since the phenomena occurring in mental disease, and particularly in injury to or degeneracy of the central nervous mechanism lend themselves readily to such interpretation. People remark that if the brain suffer damage from any cause some mental defect or deficiency usually ensues; and when for whatever reason the cerebrum becomes inactive, there is no evidence of any supra-cerebral activity remaining. So far, in short, as we can observe mental activities *ab extra,* they appear to be directly dependent upon or rather aspects of neural processes. This second view then makes mind a phase or phenomenon of matter,—one of a group of physical forces originating in the degradation of highly organized chemical substances.

There is yet a third hypothesis[1] which regards the mind and the body, so far as it passes opinion upon the essential nature of each, as distinct entities, but in some inexplicable manner bound to each other in such a way that the activities of the one necessitate correlated activities in the other. The advocates of this theory pin their faith to what may be styled a dynamic, or better, energeic relation between mind and body. They do not deem it needful to explain how this relation is possible, although theories looking in this direction are not wanting. A common one espoused by James and others considers the nerve cell as the instrument, and the sole instrument, by which mind may be displayed in a material world; and if the neural elements which constitute the *via media* for this physical exhibition of a non-physical order of being be deficient in any way, then simply mind cannot manifest itself at all, or only in a manner we call defective or abnormal.

---

[1] Typical presentations of this the now prevalent view may be found, among many other references, in Lotze, *Microcosmus;* Darwin, *Descent of Man;* Romanes, *Mental Evolution in Man;* Wallace, *Darwinism;* Fiske, *Destiny of Man in the Light of His Origin;* Drummond, *Ascent of Man;* Wundt, *Human and Animal Psychology,* pp. 5–7 and 440–445; James, *The Will to Believe,* chap. on Reflex Action and Theism.

§ 2. *The View of Experimental Science.*—Whatever be the true philosophy of the inter-relations of mind and body, modern experimental science is quite assured in the view that they are inseparably connected in their activities. The doctrine that "every psychosis is accompanied by a neurosis" has been adequately demonstrated for many people by the results of experimentation in physiological and psychological laboratories,[1] as well as in the laboratory of Nature, pure and simple, wherein she reveals to us through pathological disturbances the normal order of things; although, of course, complete and final evidence upon this subject is for the present at least quite beyond the skill of science to obtain. But it seems reasonably certain for one thing (the only one that concerns us here), that all mental activity, and physical as well, involves the expenditure of energy generated in the nuclei of neural cells. The architecture of the cell, in the absence of more suggestive experimental data, would of itself lead one to this

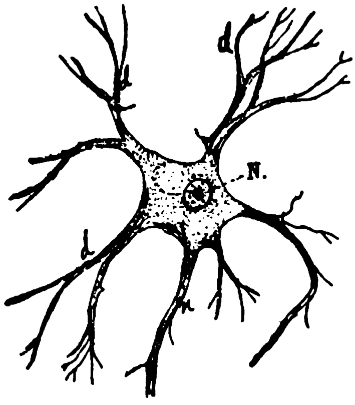

Fig. 1.

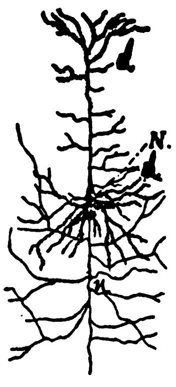

Fig. 2.

Figs. 1 and 2.—Representations of typical nerve cells (Donaldson, Growth of the Brain, pp. 143 and 145) designed especially to show the elements concerned in the reception of stimuli, d; in the generation and storage of potential nervous force, N; and finally in the transmission of kinetic nerve energy, n.

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[1] For the opinions of investigators as Mosso, Lombard, Maggiora, Kraeplin and others, see the Pedagogical Seminary, Vol. II, No. 1, pp. 13–17; Scripture, *The New Psychology*, chap. XVI; and Educational Review, Vol. XV, p. 246 et seq.

inference. The plan of construction, as doubtless every one knows, is simple,—a central body or nucleus serving the purpose of husbanding resources, as it were; and, radiating out from this are fibers or pathways some of which are designed to convey impressions in the form of sense stimuli to the nucleus of the cell, while others bind into a social union cells in different regions of the cerebral community. (See Figs. 1 and 2.)

The bodies comprising the nucleus of the cell are believed to be of a highly complex and unstable chemical composition,[1] in consequence of which they are easily broken down, the energy represented in their union thus being liberated and dissipated ultimately in incitement to motor activity, or possibly in thought. Neurology assumes, what was stated above, that all mental and physical action requires for its initiation and maintenance the liberation of a measure of this mysterious force held *in potentia* in the nuclei of nerve cells.

People do not commonly think, in part because they do not reflect upon the matter, that mental activity occurs at the expense of the contents of cerebral cells. Even critical introspection reveals thought as a spiritual activity dissociated from or at least not dependent dynamically upon physical processes. It is not easy for me to conceive that my ideas are linked to material agencies, and remain dormant except when these are active; no matter for present needs which is cause and which effect. And yet if one will note the physical accompaniments of his thinking he will not lack for opportunities to see that arduous mental work requires a comparatively great supply of blood headwards, which is shown in distention of blood vessels and in a sense of pressure or strain in the cephalic regions. Every student must have observed also, if he at times becomes attentive to the bodily concomitants of his mental processes (which, let it be said in passing, is a tendency not generally to be nurtured, but rather to be combated) that continued study increases the temperature of the head.

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[1] Ladd. *Physiological Psychology*, pp. 13 and 14, gives the following formulæ for some of the substances: protagon, $C_{116} H_{241} O^{22} P$.; cholesterin, $C^{26} H_{44} O + H_2 O$.

These phenomena are easily observable in psychological experiments, wherein it is possible to show that when a subject exerts his mind in the effort to solve a difficult problem, for example, the volume of blood in the cerebral locality increases. It was the physiologist, Angelo Mosso,[1] I believe, who first directed the attention of scientists to this in his investigations with the plethysmograph. And he was able to demonstrate the same phenomenon also in another experiment. A subject is placed upon a delicately constructed balance which remains horizontal while he is in a condition of mental repose; but when he is summoned to severe intellectual effort, or when any lively emotion is aroused, the balance tips in the direction of the head, showing that the blood is surging brainward and so of course away from the limbs. The increase in temperature during mental activity has been studied by Lombard, Schiff, and others by means of the thermo-electric needle plunged into the brains of dogs and other animals.[2] When in this latter case any sense was stimulated, as smell, the needle if placed in the olfactory region of the brain would show that heat was being liberated.

The significance of these well-known but yet little appreciated phenomena becomes apparent when they are interpreted in view of the accepted explanations of similar phenomena occurring during muscular exertion. It is a simple physiological fact that the blood supply in a muscle is greater during activity than while at rest, caused by the necessity of removing and repairing the increased waste produced by the degradation of living tissue while engaged in work. Now, it may be readily inferred that the phenomenon of augmented cerebral circulation during vigorous intellectual or emotional activity is identical in principle with the muscular phenomenon just noted. Corroborative testimony in proof of this energeic dependence of mind upon cerebral cells is afforded by the observations of physicians[1] who maintain that certain toxic products of nervous action increase *parri passu* with intensified intellectual or emotional activity. Mosso's demonstration of a distinction between muscular and neural fatigue[2] requires for explanation the assumption that nervous as well as physical action results in the accumulation of a sort of debris in the system, which is undoubtedly nothing but worn-out or degraded nerve substance, and which may heap up to such an extent as to disturb the normal functions of the neural mechanism. Especially does it tend to throw out of gear the inhibitory apparatus, paralyzing the fatigue sense, as some one has said, and thus removing the natural checks to excessive physical or mental exertion, when the organism continues in activity beyond the safety limit.

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[1] Reference is made to this phenomenon in Mosso's *Fear*, p. 68. The subject is treated in detail with respect to methods of investigation, and results in *Die Ermüding*, pp. 195 et seq. There is a very good résumé of recent investigation relating to the effect upon circulation of intellectual and emotional activity, together with the presentation of results of original researches, in the Psychological Review for January, 1899, by Angell and Thompson,—*The Relation between Certain Organic Processes and Consciousness.*

A. Binet and V. Henri in *La Fatigue Intellectuelle*, pp. 81 et seq., recognise that intellectual activity produces dilation of the cerebrum, but they do not attach so great importance to this phenomenon as many do. Their discussion does not bear directly upon the problem involved here, however.

[2] See Pedagogical Seminary, *loc. cit.*

The experiments of Hodge[3] apparently show quite conclusively, in the case of animals at any rate, that the activity of the cell depletes the nucleus of its contents, revealed in a gradual shrinking while stimulation continues, as shown in Figs. 3 and 4. This phenomenon, which he was able to detect while experimenting with a living cell under stimulation, was observed also in the examination of animals at night after a day's activities, and in the morning when they had passed a long period in rest. In the first instance the nuclei of the cells were shrunken, while in the morning they presented a repleted appearance, showing that the demands of waking life had resulted in partial exhaustion of their stock of force-producing materials.

---

[1] For instance, by Cowles: *Neurasthenia and Its Mental Symptoms;* Beard: *Neurasthenia,* edited by Rockwell; Mills: *Mental Overwork and Premature Disease Among Public Men,* Smithsonian Institute, No. IX of Toner Lectures.

[2] See for further discussion, p. 52.

[3] Some Effects of Electrically Stimulating Ganglion Cells, American Journal of Psychology, vol. II, p. 376 et seq.; and, Process of Recovery from Fatigue Occasioned by the Electrical Stimulation of Cells of the Spinal Ganglia, Am. Jour. of Psy., vol. III, p. 530 et seq.

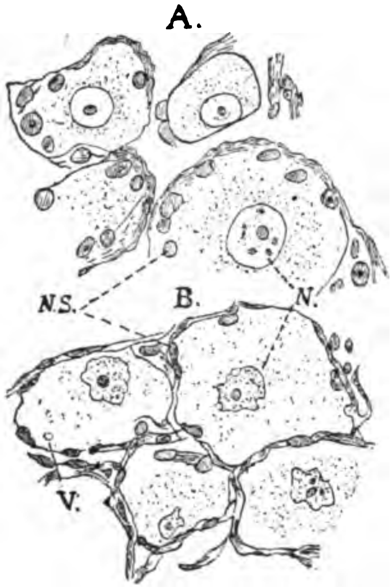

FIG. 3.

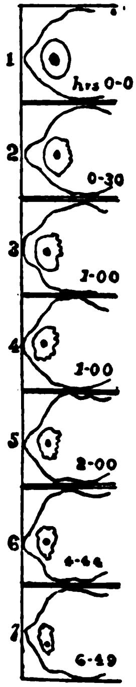

FIG. 4.

FIG. 3.—Two sections, A and B, from the first thoracic spinal ganglion of a cat. B is from the ganglion which had been electrically stimulated through its nerve for five hours, A from the corresponding resting ganglion. The shrinkage of the structures connected with the stimulated cells is the most marked general change. N, nucleus; N. S., nucleus of the capsule; V., vacuole x 500 diameters. (Hodge.)

FIG. 4.—Showing the change observed in the nucleus of the living sympathetic nerve cell of the frog, as the result of electrical stimulation. At the beginning of the experiment the nucleus is seen to be replete with what we may call potential nerve energy; but after thirty minutes of stimulation it appears somewhat shrunken, and the shrinking increases as the experiment proceeds. At the end of six hours and forty-nine minutes the shrinking of the nucleus is very marked. (Donaldson,[1] after Hodge.)

§ 3. *Neural Fatigue: Its Nature and Motor Effects.*—Modern science then conceives of the brain as a generator and reservoir, so to speak, of energy which is essential to the activity of body or mind. A proposition growing out of this is self-evident,—that when one's resources are expended in one direction they cannot at the same time be employed in another. In amplification of this axiom attention may be called to what every one has doubtless observed, that when one is engaged in hard muscular labor, he is less keen and vigorous in his mental processes; and when he is under great emotional excitement he cannot accomplish so much intellectually. Again, when the vitality of the system is dissipated in repairing the ravages of disease, the individual is unable to command so great force in the accomplishment of either physical or mental tasks. This conception, which is endorsed by experience and substantiated by physiological and psychological science, is a most important one as it relates to the ordering of the daily life of any person and especially that of a student. To but indicate its bearings here, it may be pointed out that the vigor, efficiency, and spontaneity of either physical or mental activities in the business, social, and educational world depend in some degree upon the amount of nervous capital one has on deposit in the central nervous mechanism. Abundant research has proven, it seems, that cerebral depletion (and depletion is, of course, a relative term in respect of the readiness with which it ensues in different people) reduces the force of muscular effort, renders attention less concentrated, resulting in a gradual obscuration of mental vision, and estranges the emotional nature, begetting a general condition of disphoria and apprehensiveness, and removing restraints upon anti-social impulses, as jealousy, anger, irritability, and similar traits of a low order of development.

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[1] Growth of the Brain, p. 320.

Mosso,[1] Maggiora,[2] Lombard,[3] Bryan,[4] Kraeplin,[5] and others have shown that in a condition of fatigue muscular activity is lessened in force and reduced in rapidity; and this is no doubt to be accounted for in largest part by the fact that what we are wont to call muscular fatigue is in reality quite largely central or nervous fatigue. When a subject under experiment continues to exert force through the arm, say, until his muscles become perfectly inert, they may then be stimulated with electricity to act with initial vigor, indicating that they are still in workable condition; and after a period of stimulation in this way, the will of the subject remaining quiescent, he can again voluntarily energize the arm, as is shown in the following figures.

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[1] Ueber die Gesetze der Ermüdung, Archiv. für Phys. (DuBois Reymond.) Hefts, I and II, 1890.

[2] Ueber die Gesetze der Ermüdung. Untersuchungen an Muskeln des Menschen. Archiv. für Anat. und Phys. (DuBois Reymond.) Physiologie, 1890, pp. 89–243.

[3] Some of the Influences which Affect the Power of Voluntary Muscular Contractions. Journal of Physiolgy, vol. XIII, pp. 1 and 58.

[4] The Development of Voluntary Motor Ability, Am. Jour. of Psych., 5, p. 123 et seq.

[5] A Measure of Mental Capacity. Popular Science Monthly, vol. 49, p. 756.

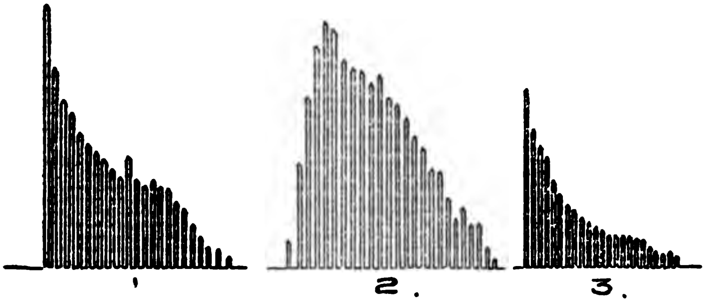

FIG. 5.—Showing ergographic tracings (1) in voluntary effort, (2) in electrical stimulation of nerve, (3) in electrical stimulation of muscle. (Scripture[1] after Mosso.) The relative heights of the tracings represent the relative amounts of energy expended in the several forms of stimulation. It can be seen that in voluntary effort the subject gradually loses power of exertion and is soon unable to exert any force whatever; but if at this point a nerve leading to the muscle which has been acting (in this instance the middle finger was exercised) be excited by electricity, the tracings show that the muscle is as vigorous as ever. The fatigue in the voluntary effort must then have been central or mental. Again, if when action ceases from nerve excitation the muscle be directly stimulated there is once more a return of power, indicating that the muscle itself fatigues much more slowly than the nerve mechanisms concerned in voluntary effort.

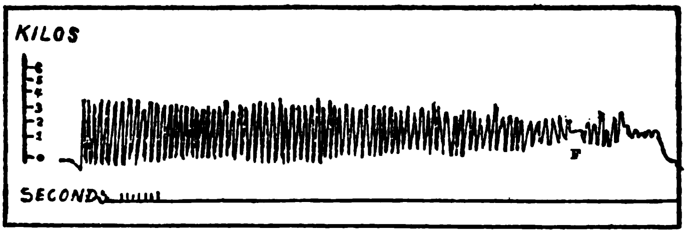

FIG. 6 shows the rhythm in the fatigue of voluntary effort (Scripture[2]). At F is shown a period when the subject could exert no force whatever, although he earnestly endeavored to. Soon after this space of paralysis, however, there is a return of ability again for a brief time. These tracings were obtained upon the dynamometer by means of the hand grip.

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[1] The New Psychology, p. 231.
[2] Ibid., p. 229.

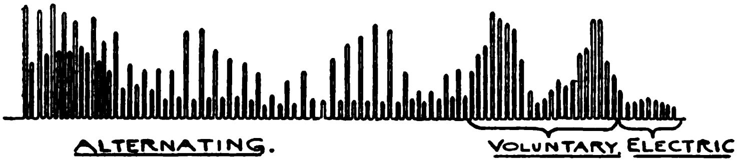

FIG 7. This figure (Scripture[1] after Lombard) shows the independence of muscular and voluntary fatigue. Lombard first stimulated a muscle by volition, then by electricity, and continued the stimulations alternately as indicated in the figure. At first the voluntary tracings show greater force exerted, but this is gradually lost until the effect for volition and from electrical stimulation are about equal. Then there is a recovery of volitional power, which subsides again, only to return in a sort of rhythmical period, which is very apparent from the tracings.

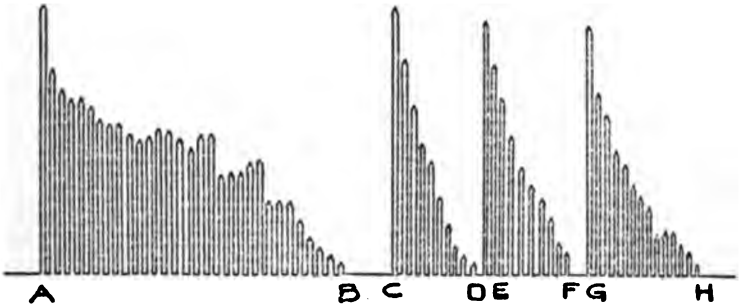

FIG. 8 shows the effect of mental work upon the power of contraction of the finger at various hours of the day. (Mosso, loc. cit.) The first curve, from A to B, indicates the amount of work which could be done at 9 a. m. From 2 p. m. until 5:30 p. m. the subject was under great mental strain while conducting an examination in the university. After the examination, at 5:45 p. m., the curve from C to D was gained. The first contraction of the finger shows as much power as in the morning, but the energv is soon exhausted. Then after supper, at about 7:30 p. m., the increase from E to F was taken, and it indicates a slight increase in the endurance of energy. Finally at 9 p. m. the fourth curve was made, showing a slow recovery of original power.

This principle in its general bearings has been recognized practically in every-day experience, particularly in the training of athletes; for it is well known that their physical vigor and endurance depend in great degree upon their mental condition (See Fig. 8), or as the saying goes, upon their nerve. They are expected during the season of training to secure an abundance of food and sleep, and to abstain from dissipation so as to keep the nervous system in thorough repair; and it would doubtless not be an overstatement to say that athletic contests are won by virtue of the power and control conferred upon the athlete whose life is ordered in conformity to the requirements of neural hygiene rather than by superiority in muscular brawn *per se.*

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[1] Ibid., p. 232. The figure is a copy made by Scripture from an original record furnished him by Lombard.

The visible manifestation of cerebral fatigue most in evidence in the affairs of daily life is the lack of power to secure delicate and sustained co-ordination of bodily activities. Tasks demanding exact control and fine adjustment of muscles, as in delicate workmanship for instance, are exceedingly difficult when one is nervously exhausted. The explanation is doubtless found in the fact that different sections in the brain are charged with the control of certain definite motor processes, one section having general oversight of the large, coarse, fundamental movements, a second one governing the secondary and more complex movements, while still other sections control the peripheral, the most finely adjusted movements,—those for instance, involved in the co-ordinations of the fingers and the articulatory apparatus in speech.[1] This highest level, to employ Hughlings-Jackson's term,[2] may be regarded as the co-ordinating mechanism, *par excellence,* of the nervous system. Now, in cerebral fatigue, as in intoxication or mental disease, this level seems to suffer first because it is the most unstable; and nervous depletion will then manifest itself at the outset in inability to delicately correlate these most intricate movements.

This is at the root of much of what in the common affairs of life we call "carelessness," one of those terms which conveniently covers up a lack of critical analysis, grouping, and interpretation of phenomena. An individual who in a condition of fatigue is performing a task requiring exact adjustments of any kind, as fine writing for instance, will be unable to co-ordinate his actions so perfectly as when nervously refreshed, and this will result in blundering, coarse work. Warner[3] ascribes this want of precision, which is simply inco-ordination carried to a point where it becomes noticeable, to the spasmodic functioning of nerve cells in a condition of fatigue. The inhibitory apparatus does its work less efficiently; but inhibition is absolutely essential for fine adaptations in motor activity. The Hughlings-Jackson theory would account for the phenomenon under consideration by declaring that the co-ordinating areas in the brain are unable to act with accustomed authority, and movements result which are not so fully under the direction of the will.[1] This view is strongly supported by data gained from the investigations of Mosso,[2] Lombard,[3] and others. But whatever the neurological explanation may be, it is enough for practical purposes to recognize that the exhaustion of nerve centers results in a general lessened power of delicate co-ordination of motor activities.

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[1] For a fine treatment of this subject see the Pedagogical Seminary, Vol. VI, No. 1, pp. 5–65. The matter is brought down to date in this article. See also Mercier, *Sanity and Insanity,* Chaps. I and II.

[2] See Anderson, in Hack Tuke's *Dictionary of Psychological Medicine,* Vol. I, pp. 440 et seq. for a discussion of Hughlings-Jackson's theory, which seems now to be accepted by practically all physicians.

[3] *The Study of Children,* pp. 52 et seq.

Again, as was intimated above, fatigue has a retarding influence upon the rapidity of physical action.[4] This phenomenon is apparent in the case of athletes who are contesting in activities demanding ready response to stimulus. When fatigued they do not start so readily in running, or gather themselves so quickly or act with such continued force in defense or offense where promptness in execution and sustained power are the decisive factors. When it is realized how much of the success of life depends upon quickness and certainty of action in the countless situations requiring these qualities in which one is placed every day no matter what his calling may be, the importance of preserving to the fullest extent possible the hygiene, or perhaps better the vigor of the brain can be appreciated.

§4. *Neural Fatigue: Intellectual Effects.*—While nerve depletion has indeed a very unhappy influence upon motor abilities, still the harm done here is probably not so great as that sustained by the intellectual faculties. The latter consequence of brain fatigue is of chiefest concern to the student alike in his immediate daily duties and in his future vocation, which will for the most part require of him keen perception, accurate, ready memory, and, above all, careful and judicious reasoning. From what has gone before it must be apparent now that fatigue impairs those cerebral conditions which are essential to normal intellectual activity; and the most prominent effect of this in the mental life is to render attention less concentrated and enduring than when one is in good neural form, so to speak. Any person who has endeavored to apply himself to arduous undertakings when his resources have been too heavily taxed knows that it is with great difficulty he can hold his mind to the thing in hand, and he is likely not to succeed at all in the attempt. As James has said,[1] one grasps at everything in order to find relief from the object before him. At this time ideas crowd into the focus of consciousness which in seasons of mental vigor can be inhibited; and the upshot of it is that distraction ensues; the mind grows inaccurate and lethargic, and arrives finally at a state which, lacking a better term, we may name stupidity.

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[1] Cf. Scripture, *The New Psychology*, pp. 228 et seq.

[2] Loc. cit.

[3] Loc. cit.

[4] See Scripture, op. cit., pp. 128–129, and 243 et seq.; also Bryan, on *The Development of Voluntary Motor Ability*, Am. Jour. of Psy., 1892, p. 123.

From the point of view of neurology the dispersion of attention in cerebral fatigue is simply explained. It has already been said that the co-ordinating, the regulative functions of the brain are disturbed in neural depletion, and there attends this condition a sort of independence of the various nerve centers resulting in lessened subordination of irrelevant motor activities. The individual does things that in better times he would be able to inhibit. Now, the neural capacities essential for right physical co-ordination are, it seems, requisite as well for mental co-ordination; and what renders one impossible will interfere also with the proper action of the other Concentrated attention requires the convergence of the mental powers upon one point, with of course restraint of disturbing impulses; but as the inhibitory processes are less vigorous and constant in fatigue, mental application is as a consequence less perfect. Ill-adjustment, disperseness, whether found in physical or mental action, are due to the same causative agencies. Mental degeneracy begets physical as well as psychical inco-ordination; imbecility is characterized no less by lack of control and balance physically than mentally. It seems as if we are able to say that on the whole those who have the surest motor control have at the same time superior possession of their mental powers.[1]

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[1] *Psychology, Briefer Course*, p. 225.

When it is remembered that fatigue dethrones attention, so to speak, it is not difficult to see why it should so soon beget stupidity, since a scattered mind cannot exhibit keenness, readiness, or accuracy in any of its operations. We would expect in the first place, that perception would be less discriminating, and this has been demonstrated by extensive investigations upon the several senses.[2] The writer has studied this subject in the schools of Buffalo, N. Y., making use of simple experiments which in a way tested the keenness and accuracy of interpretation of sense stimuli; and he has found that two and one-half hours' work in school lessens ability on the part of most pupils to discriminate colors, as tested by sorting colored yarns, or sounds as determined by the tone tester, or touch sensations as determined by the aesthesiometer, which Griesbach claims is the best test for mental fatigue.[3] The data yielded by these studies are in general in accord with those reached by such investigators as Kraeplin,[1] Burgerstein,[2] Sinclair,[3] and others.[4] These results will certainly not awaken surprise in any one who has observed the sharpness of his own senses at different hours during the day, and under varying circumstances with respect to fatigue. One may hear those about him say frequently something like the following: "I derive much greater benefit from visiting an art gallery in the morning than at 4 o'clock in the afternoon;" or "I find more pleasure in going out into the fields and coming in contact with nature in the morning hours than later in the day, for I see more, or at least I appreciate more; everything has a meaning for me now which is not apparent at other times. There are details and harmonies in sound, in color, and in form which I apprehend when I am refreshed but which I miss when my mind is tired." And the *rationale* of this is not obscure. It is not that there is less of beauty and richness in nature in the late hours of the day, nor that the visual or auditory sense organs are incapable of receiving stimulations therefrom; but the structures in the brain through which interpretation proceeds, because of the wastedness of their substance, if one may so speak, and the accumulation of obstructive materials, hinder the efficiency of the mind's action. Doubtless every student has noticed that when his energies are at a low ebb, whether abnormal in persisting throughout the entire day, or week, or month, or whether occurring only at intervals in the daily rhythm, yet in any case his perceptions become less keen and accurate, and he grows dull in all work that depends upon clearness of perception, as in the apprehension of forms in language, to some extent in mathematics, and to a considerable degree in the mechanic arts, not to mention other studies.

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[1] For a summary of recent investigation relating to this subject, see Burk, *From Fundamental to Accessory in the development of the Nervous System*, Pedagogical Seminary, vol. VI, No. 1, and Reprint. See also Oppenheim, *The Development of the Child*, chaps. III, IV, V; Warner, *The Study of Children*, chaps. III to XIII; Donaldson, *The Growth of the Brain*, especially chap. XVIII; Halleck, *Education of the Central Nervous System*, chap. XI; Mercier, *The Nervous System and the Mind;* Ross, *Diseases of the Nervous System;* Flechsig, *Seele und Gehirn*, 1896; Hartwell *Add. and Proc. N. E. A.*, 1893; Ireland, *Blot on the Brain*, p. 257, et seq.

[2] See for the results of some investigations: Gilbert, *Studies upon School Children in New Haven*, in Studies from the Yale Psychological Laboratory, vol. II; Sinclair, *School-room Fatigue*, Educational Foundations, May and June, 1896; Dresslar, *Fatigue*, Journal of the Anthropological Institute, 1888, p. 153 et seq.; O'Shea, *When Character Is Formed*, Pop. Sci. Mo., Sept., 1897; also, *Some Practical Phases of Mental Fatigue*, Pop. Sci. Mo., August, 1899.

[3] Too much reliance, however, should not be placed upon the results of the aesthesiometric test. For myself I never could feel quite sure of my data. See for a critical discussion of this method two articles by Leuba and Germann in Psych. Rev., Nov., 1899.

The senses are not the only nor the principal losers when the mind is over-wearied. Memory, both in its retentive and recollective functions, becomes halting and unreliable. Who has not observed this in his own daily experiences? Ideas which one has firmly fixed in his head, and usually has in hand when he needs them, cannot now be readily summoned before consciousness, and often keep out of reach altogether. One has greater difficulty, too, in making ideas fast now than on other occasions. It seems as if the bewildering mechanism of the associative system, regarded from the neural point of view, becomes in a measure thrown out of gear, one might say, in fatigue; and in this event, memory processes easy and natural in normal mentation are so no longer. Under such circumstances one is apt to find that making use of devices for recalling ideas that at other times prove useful now are worthless. There is apparently an obliteration of old mental pathways; the energies of intellection are not discharged in the customary grooves, and the thought life then becomes to a greater or less degree either monoideistic or atomistic. As Ribot says,[1] "Fatigue in every shape is fatal to memory. The impressions received at such time are not fixed, and the reproduction of them is very laborious and often impossible. . . . When the normal conditions are restored memory comes back again."

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[1] A Measure of Mental Capacity, Pop. Sci. Mo., vol. XLIX, p. 756.

[2] Quoted by Kraeplin, loc. cit.

[3] Loc. cit.

[4] Since the above was written, the writer has read *La Fatigue Intellectuelle,* by A. Binet and V. Henri, in which the propositions herein set forth are in the main substantiated. See for a recent summary of studies upon this point, Kotelmann, *School Hygiene,* chaps. VII and VIII.

It is not needful to linger over the significance of these facts for the student. His success in the acquisition of learning; or to put it in a way which would better represent the chief aim of education, in building up a unified personality with interests and activities adapting him most harmoniously to his social and natural environments,—his success in this depends so greatly upon the power of retaining impressions and summoning them forth when needed to guide action, that it would be impossible to overestimate the mischief that circumstances can do which militate against achievement of this sort. And then, regarding the immediate demands made upon the university student in his class-room, it is evident that the incapacity to fix firmly and in such a way as to be able to recall readily the ideas gained in the different studies is a thing of serious mien, as those who draw too heavily upon their energies in dissipation, in neglect of the requirements of food, air, and exercise, or in other ways, doubtless have occasion frequently to realize.

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[1] *Diseases of Memory*, chap. V.

Fatigue works most serious harm in the elaborative or reflective processes. Reason requires co-ordination of ideas; it necessitates holding before consciousness in a single act of thought two or more objects, viewing them together to discover the relations which they bear toward one another. It can be seen that to accomplish this requires good control and balance neurologically, and so psychically. But this is just what fatigue makes impossible, not absolutely of course, but relatively. Any person's experiences will afford illustrations in plenty. We all know how difficult it is, or even how impossible it is to attend to matters requiring elaborate reasoning at a time when the vitalities are run low. We generally defer the consideration of such matters until a more favorable period when mental strength has been regained. We attack our mathematical problems in the morning rather than at 5 o'clock in the afternoon. Even social custom has recognized this and has assigned the later hours of the day to occupations and pastimes requiring little concentrated effort of mind.

§ 5. *Neural Fatigue: Emotional Effects.*—It will not be needful here to do more than to refer briefly to the fact that the cerebral states which give rise to physical and intellectual inco-ordination and errancy have a similar effect in principle upon the emotional life. People are generally aware of this, and they freely condone the bad temper of individuals at certain seasons because of their unhappy physical condition. If one studies the matter at close range, he can see that the people who surround him are sometimes transformed in temperament under an ordeal which overdraws their account in the nervous system. It will of a certainty impress one who will turn his attention to the matter to observe how in a siege of neurasthenia anti-social qualities, as irritability, jealousy, hatred, anger, and the like take possession of an individual who in fairer weather is well poised and not too conscious of self in relation to others in his neighborhood.

If one should seek for an explanation of these phenomena, he would find the most rational one, and one in every way consistent with the principles involved in the preceding discussion, in the theory of recapitulation; which postulates that the individual retraces in some measure and retains in his own being to a certain extent the principal mental structures, intellectual and emotional, developed throughout racial history. The emotions most prominent in earlier phylogenetic epochs have been those concerned with the preservation of self against the enemies lurking everywhere, and which constantly threatened annihilation.[1] It was self against all the world else. The development of the altruistic or social emotions has been of very recent origin in racial evolution; and by virtue of a principle of heredity whereby latest developed phylogenetic characteristics are most unstable in ontogenesis, one is warranted in holding that while the social emotions are for the most part pre-eminent in the individual under normal conditions, yet these very emotions are most affected in fatigue, when the last formed and highest areas of the brain are first disturbed in their functioning. The process in racial ascent of gradual specialization of brain areas to take on more and more delicate and elaborate motor and psychic functions has resulted seemingly in the highest bodily, intellectual, and emotional activities becoming so intricately interwoven that one cannot suffer except at the expense of the others. Speaking neurologically then, the conditions requisite for co-ordination in intellectual and motor activities are requisite for the efficient control by the highest social emotions of those which are of a lower order, and represent earlier predominant characteristics alike in phylogenetic and in ontogenetic history.[2] A matter which is well recognized may be alluded to in this connection,—while under the influence of alcohol,[1] or in cerebral disease,[2] lower and more egoistic impulses usually gain mastery of the individual; and thus in some of their effects fatigue, cerebral disease, and intoxication seem closely related, explicable upon the supposition that all three attack the highest levels in the brain first and prevent, therefore, full and sure control of lower areas.

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[1] One is impressed with this thought as he reads accounts of animal life in its native wildness,—such accounts as one finds in Kipling's books, or in Thompson's *Wild Animals I Have Known*, or Cornish's *Animals at Work and Play*.

[2] For a detailed presentation of this theory, see, Marshall: *Biological Lectures and Addresses*, lecture on Recapitulation; Morgan: *Habit and Instinct*, whole book; Drummond: *Ascent of Man*, whole book; Le Conte, *Religion and Evolution*, p. 133 et seq.; Oppenheim, op. cit., chaps. I and II; Haddon: *The Study of Man*, Part II; Baldwin: *Mental Development, Methods and Processes*, chaps. I, IV, XIII; Hall: *Fear*, American Journal of Psychology, vol. VIII; Burk, op. cit.; Pedagogical Seminary, vols. III, IV, V, articles on Reverie, Mental Automations; Bullying and Teasing, Games and Plays, Truancy, etc., etc.

Again, it has been emphasized by students of this particular phase of fatigue, as Cowles,[3] Beard,[4] Dresslar,[5] and Mosso,[6] that fears which in the normal life are held in check are now apt to assert themselves and color the emotional life. There rises up in the early stages of fatigue a sense of dread of an indefinite something which is about to happen; and, as depletion progresses, particular objects persist before the mind and fill the individual's life with uncertainty and apprehension. In business the neurasthenic is afraid to assume any responsibility. In the class-room the pupil is unduly self-conscious and lacks confidence in his own ability; he is timid in the presence of others, and morbidly afraid of possible criticism. In short, the vigor of what we may call personality denoting one's psychic *ensemble,* as it were, is reduced, and this is revealed in the emotional depths as quickly, perhaps more quickly, than in any of the other parts of the being.

It would seem possible to explain these latter phenomena also by the theory of recapitulation. One of the most important and serviceable emotions in the development of the race has been fear, manifested toward a multitude of objects incessantly threatening danger to life and limb. These experiences have left their trace in the nervous organism even of the human species, and each individual must receive them as a heritage in the form of "broken reflex arcs"[1] or "rudimentary instincts."[2] In the normal life these reverberations of a remote past are not distinguished because of the strong tone of the higher psychic life; but let this supreme self yield its efficacy at any time and then these recrudescences from phylogenesis well up into consciousness.

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[1] **See Wilson, Drunkenness, p. 29 *et seq.***

[2] **See Mercier, *op cit.*, p. 308 *et seq.***

[3] **Loc. cit.**

[4] **Loc. cit.**

[5] **Loc. cit.**

[6] **Loc. cit.**

Lastly, it may be said, although it scarcely needs argument, that ethical feeling, being a most highly complex social attitude or attunement and a recent *addendum* to the ancestral record, is quickly estranged by whatever disturbs the delicate normal functioning of those material media through which spiritual characteristics are made manifest in this physical world. Collin,[3] Wey,[4] Morrison,[5] Wright,[6] Lombroso,[7] Ribot[8] and Mercier,[9] who have studied moral degeneracy as a social and as an individual phenomenon, have testified in confirmation of the doctrine that moral obliquity is generally the accompaniment of defective physical conditions, and in all probability is the legitimate issue of these. When the highest and most essential cerebral structures become impaired through dissipation of vital energies or improper nutrition, whether due to ignorance, excess, or asceticism, one becomes then a fit instrument for anti-social and immoral impulses; but let him preserve within himself as an individual the vigor of those organs which nature has with unending patience developed in the evolution of the race and he will have a superior chance, to say the least, of adjusting himself in harmonious relations to his social environment.

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[1] Ribot.
[2] Spencer.
[3] *Papers in Penology*, 1891, pp. 27–28.
[4] Ibid., pp. 57–69.
[5] *Juvenile Offenders*, Part II.
[6] American Journal of Neurology and Psychiatry, vols. II and III, pp. 135 et seq.
[7] *Female Offenders*.
[8] *Psychology of the Emotions*, chap. XIV.
[9] *Sanity and Insanity*, p. 308. *et seq.*

CHAPTER II.

CEREBRAL HYGIENE AND ECONOMY IN STUDENT LIFE.

§1. *The Student's Obligations to the State.*—In view of the foregoing it ought not to be necessary to make apologies for urging observation of the laws of cerebral hygiene and economy by the student in his daily life, as a member at present of an educational community, and as a leader of social progress when his preparatory training shall have been completed. But it is not infrequently the case that college youth manifest little interest in that which has the appearance of relating to their immediate well-being, physical, moral, or intellectual; it is indeed esteemed at times to be a mark of superiority to show indifference toward things of this character. It is not apparently believed in a serious manner that the attainment of the highest degree of perfection in respect of all the elements of personality should be the supremest concern of every individual whether within or without the university. But even if a student cannot see that it is a duty he owes to himself to promote in every way possible physical and mental vigor and balance, yet as a factor in the social whole and maintained during his educational career by the state in the hope that he may return to confer blessings upon it, to be a guide in morals and to make less rigorous the struggle for physical existence—these considerations make it obvious that there is absolutely no course left him but to conserve his energies and employ them to the best advantage, that he may repay the obligation due the community that has favored him. In the support of the university the state provides means for a few of its members to receive the benefits of the broadest education; it has then a just right to demand that every individual so favored shall profit by these opportunities to the fullest possible extent. If for any remediable cause, as dissolute living or excess, causing waste of vital forces, or failure to provide nervous energy equal to the need in profiting by instruction here, a student does not make the most of his privileges, then from the community standpoint such an one is apostate to his plain and simple duty. Being a recipient of the bounty of the commonwealth, his indebtedness to it cannot be gainsaid; and it is a wholly erroneous conception which persists against all reason in some university communities, especially in those sustained at public expense, that a student is not beholden in his conduct to any one but himself and his guardians.

§2. *The Study of Psychical Processes,—Dangers, Advantages.*—It perhaps should be said at this time that, in general, it cannot but prove detrimental to become too greatly concerned about one's own physical or mental processes. One who introspects much for egoistic ends can accomplish but little in this world; thinking all the time about life functions tends to render them abnormal. Nature has evidently designed that for the most part one should be interested in objects and aims outside of self; and the machinery of the organism will run most smoothly when it is left largely to the oversight of subconscious agencies. But while this as a general principle is of superior worth in the practical affairs of life, it yet does not obtain rigidly as it relates to the subject under discussion,—the most frugal and efficient methods of generating and expending nervous energy. Every one knows, to illustrate by a single instance, that in the matter of food, which is the most important factor in the production of vital force, there are great difficulties to be overcome in breaking away from the dogmas and practices of tradition. But recent investigation has made the beginnings at least of a science of nutrition, wherein are set forth the needs of the organism that it may best fulfill its function as an instrument of mind and as a mechanism designed to accomplish a given amount of work, and how these needs may best be met: yet the community at large for whom alone these things are of value, has exhibited little interest in them thus far. While instinct may be trusted a good way in advising us what and how to eat, yet it is certainly not an infallible guide, especially since it is not within its scope to suggest improved methods of manufacturing foods, and even new kinds of foods themselves. It merely determines sort and quantity when articles are presented, so its sphere of usefulness is quite limited. Again, we tend naturally in most instances to save needless wear and tear of mind and body, yet as we shall see later there are avenues of waste which continue to drain off much of our energies until we get to work consciously to stop them up. In respect to these matters, then, study cannot fail to be of benefit to every person, teaching him how to make the best kind of a machine of himself, so to speak. But when once he learns the trick, his mind may with advantage be turned altogether in other directions; he need not, he must not, be in constant query respecting what he should eat, and how he should work.

But now we are all apt to feel and often to say that we have thus far been steering our barks in a given direction, and considering how the winds have favored us, and what progress we have made, we cannot think we have been on the wrong tack. There seems to lurk within the bosom of every one of us a conviction begotten of the tendency to regard self as the standard of excellence, that we cannot be very greatly improved upon; but this belief, it need scarcely be said, is rarely if ever the result of much reflection upon one's attainments and limitations. While one may find occasion for congratulation that he is as well balanced as he is, and that his energies are devoted as largely as they are to profitable production, yet he needs to recognize, or most of us do at any rate, that we are hindered in a thousand directions by obstacles and restrictions which seriously impair efficiency. Most of us probably have little conception of what a perfect man-machine would be, one who is thoroughly balanced in mind and body, who always has himself well in hand, who has abundant energies for the tasks which lie in his way. One who, looks at life as in a process of evolution, which seems in no wise to be yet complete, sees that in the matter of human perfection (which means nothing more than consummate adjustment to one's social and natural environments) people may be aided in individual cases in attaining thereunto by compliance with the natural laws to which harmonious adjustment is required. This conception leads one to believe in the possibility of continuous improvement, while at the same time holding securely to all that has been accomplished, and being devoutly thankful therefor.

§3. *The Educator's Concern With Cerebral Hygiene.*—Such a bulletin as this would doubtless not be necessary if there were persons in the community whose special interest and duty it was to bring the matters herein discussed in their practical aspects to the attention of the people at large. But there are at present few such persons in any community, and in most places there are none at all. One would naturally suppose that these affairs would lie within the domain of the physician; but as a matter of fact physicians have hitherto been dealing largely if not entirely with disease, with therapeutics, while the thing we are considering is of a wholly different character. One's energies may run out on the debit side for so long a time, without proportionate income on the other side, that hostile forces overpower him; disease seizes upon him, and then the physician seeks to aid him in winning back wasted strength. But it is a far cry from the highest efficiency of mind and body to that disintegrated condition realized in actual disease. One may be living on a low plane so far as the generation and conservation of vital energy is concerned, and yet not come under the eye of the physician. The M. D.'s have not yet dealt largely with the subject of nutrition for healthy beings; and they have only glanced by the way at all the various avenues through which energies are dissipated in prosecuting the work of daily life. Indeed, medicine seeks to cure, not to prevent, nor to raise the general level of organic life. A few medical writers have, however, given these matters some attention, but it would require little space to enumerate them and tell what they have done.[1]

As things stand at present it falls to the educator to consider some of these physical phenomena which directly determine the fruitfulness of his teaching. It was generally thought in older times when the relation of mind and body was quite differently understood, that the teacher's duty was fulfilled when he simply offered mental aliment to his pupils. If they did not receive and digest it, he sought to aid them in the process by generous stimulation with the cane and the birch.[2] But in our own day an intelligent teacher knows that when his pupil is lacking in available cerebral energy his instruction will be of little avail, either in cultivating the intellect or in fashioning character; and he ascribes shortcomings more often to defective physical conditions than to lethargy or perverseness of the will. He sees then the necessity for considering those factors which inevitably decide whether what he presents will be wrought into the mental structure of his pupil or whether it will simply be an added load to an already overburdened mind,—overburdened because of deficiencies in the neural structures through which it is manifested and by which it is determined.

§4. *Studies at the University of Wisconsin: Purpose and Methods.*—Holding these views the School of Education, at the instance of the writer, sent out to all students in the University of Wisconsin, in the spring of 1898, a questionnaire relating to the subjects discussed in the preceding paragraphs,—the modes of producing cerebral energy and conserving it so that it may as fully as possible be expended in profitable directions. The primary purpose of the questionnaire was to turn the thoughts of students to a consideration of the hygiene of food, exercise, ventilation of living and sleeping rooms, the arrangement of the daily program, the use of particular materials in writing, and similar matters of practical importance; and it was hoped in addition to obtain statistical data relating to these affairs which would be of some local, and perhaps also of general interest. The questionnaire, with the explanatory letter, follows:

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[1] The best work with which I am familiar is Stevenson and Murphy, op. cit, 3 vols. This is not adapted, however, for general reading; nor does it devote much attention to mental hygiene and economy. Other good works are Parks: *Practical Hygiene;* Wilson: *Handbook of Hygiene and Sanitary Science;* Rohe: *Text book of Hygiene.* Carpenter's Physiology has some very good hints on hygiene. Martin: *The Human Body,* chaps. XX, XXI, and XXIX discusses in a scientific and practical way some of the problems herein considered.

[2] See a most interesting book,—Cooper: The History of the Rod.

MADISON, MARCH 5, 1898.

The accompanying circular is sent you in the hope that you may be able to give me some exact information respecting your mode of life in the University. This is not requested for any personal reasons whatever; but it is desired simply to be collated for scientific purposes with similar data gained from other students. In the course in Child-Study much attention is given to the subject of mental hygiene and economy during the period of school and college life; and it is the plan to use the information obtained from the responses to this circular in the regular Child-Study work, and as the basis of a bulletin to be issued later for the guidance of students in respect of the important matters referred to herein. It is the purpose to present in this bulletin the results of research regarding the manner in which one's daily life should be ordered so that he may do the greatest amount of intellectual work with the least expenditure of energy, and without endangering mental health and poise; but in order that local conditions may be made more suitable, if desirable, for student life, it is needful that those conditions be understood just as they exist. I trust, therefore, that you will answer the enclosed questions as fully, and particularly as *accurately*, as possible. If you are not sure in any of your replies, say so. If there are any questions you do not care to answer, omit them; but I wish to assure you that your name will in no case be known to any one but myself and my assistant, and it is recorded simply as a guarantee of earnestness and good faith in the replies. If your answers are referred to for any purpose whatever it will be by number. Please to return the circular in the enclosed envelope as soon as you can conveniently supply the information requested. Drop the envelope in one of the boxes labeled "Child-Study" in Library, University, or Science Hall. Be as complete and detailed in your answers as your knowledge will warrant, using more paper if necessary.

Very respectfully yours,

M. V. O'SHEA.

CIRCULAR.

I. Food:

1. Under the headings Breakfast, Luncheon, Dinner, please write in detail what you customarily eat and drink at each meal.

If possible, keep account for a week and indicate number of times each article is eaten; thus: oatmeal, 7; beefsteak, 5, etc.

Be specific regarding the quality of each article, as *bread:* graham, whole wheat, white, rye; *meat:* beefsteak, roast beef, roast chicken, enumerating each separately.

Indicate also, as accurately as possible, in what manner and how thoroughly each article is cooked. Observe particularly whether the meat is boiled, broiled, roasted, or fried; how long the oatmeal and other cereals are cooked, whether over night or only for an hour or two in the morning; whether the bread is light or heavy, etc. (Your landlady will doubtless gladly inform you upon these matters if you ask her, and she will probably be pleased to note your interest in her culinary enterprises.)

2. What articles of food do you like best? What ones really form the substance of your dietary? Do you eat between meals, indulge in midnight lunches, etc.? Do you have dinner at midday or at night?

II. Sleep:

1. Do you sleep soundly? Dream much? How many hours do you plan to spend in sleep? How late do you study at night? When do you go to bed? What time do you arise in the morning?

2. Have you ever studied all night, or nearly so? What effect did it have upon you? Has knowledge gained at such time been enduring?

III. Study:

1. How many hours per day? What are your study hours? Are they regular and uninterrupted, or otherwise? How many hours may you count upon with certainty to be entirely uninterrupted during the day? During what hours of the day are you at your best? When are you dullest? Do you stimulate yourself artificially to study? If so, how?

2. Indicate the amount of time you spend upon each of your studies? How many hours of written work each day? Pen or pencil? If pen, fine or blunt point? Metal holder? If pencil, soft or hard?

IV. Health:

1. Headaches? Indigestion? Colds?
2. Have you had your eyes examined by a skilled oculist?
3. Indicate time spent by you in gymnasium; in open air.
4. Do you dance? How frequently? How late?
5. Do you smoke? Cigars, Cigarettes or Pipe?

V. In General:

What do you pay for board? For room? How large a room have you? How many in it? How heated? How ventilated? Do you board yourself? Do you do your own washing? How much work, manual or otherwise, do you undertake outside of your University duties?

A few words respecting the distinct purpose of this study and the method of its prosecution should be added here. In the first place, it was fully realized that it would not be possible to obtain a great body of accurate, scientific information by this method, especially in regard to the subject of food, in respect either of quantity, quality, or the character of its preparation for utilization in the organism. No effort was made to ascertain how much food was eaten, for the reason principally that such a request could not be complied with; and this information was not particularly desired anyway since there was no intention of enquiring in minute detail into local practices because of the vast amount of labor it would entail without being of great value. What was wanted was a general statement of the articles of food which form the substance of students' dietaries; and it was thought to be sufficiently definite for the purposes of the study to assume that the amount and quality of the articles consumed would be such as have been commonly found to be the case elsewhere. Regarding the subject of cooking, it was not hoped that exact data could be obtained, since it would be difficult for students to determine this with absolute accuracy. It was thought, however, that some reliable impression could be gained, especially of the cooking of starchy foods and of the especial manner of preparing meats. The results have realized all that was anticipated, although in some instances the answers were for the most part useless except as they could be interpreted from other papers that were written by students living under similar conditions,—obtaining their food at the same table, for example, and dwelling in the same house. In the interpretation of data the writer makes use of his own observations gained while visiting several boarding clubs and restaurants. His experience, it may be added here, has substantially corroborated the results obtained from the questionnaire.

The data furnished in response to questions relating to exercise, habits of eating with respect to hours and irregularities, the size, heating, and ventilation of living rooms, the arrangement of the daily program, the employment of writing materials and the like, are more complete and definite and are reasonably satisfactory. The information respecting health, however, is probably only in a relative way of value, since students are not able to observe such matters with scientific accuracy; and they, in common with other people, are not good judges of their own status in this regard anyway, since they have no standard for measurement except their own experiences, which are too apt to represent to them normal conditions, however far they may be from this. It was expected, though, that the data here would be valuable only in a general way as indicating instances of important abnormal conditions which interfere with the efficiency of the individual's work.

While it was hoped to gain from the investigation some reliable estimate of the energeic aspects of student life in our community, yet the primary object after all in asking students to report the practices of their daily lives was (and this has been already said) to direct their attention to a few of these vital things in the belief that this in itself would serve to correct some wasteful habits. It was thought it would be of value, also, to suggest to students the necessity of intelligently arranging their dietaries so far as they could control the matter, with the purpose in view to provide the largest amount of energy at the least expense, whether regarded from the point of view of the effort required to transform certain foods into nervous force, or of the apparently more practical aspect of the financial outlay. This expectation has been realized in a measure at least, since there has come to the writer trustworthy evidence that the questionings of students in regard to the articles of food and cooking has resulted in some improvement in both directions. It was believed, finally, that this would be a good way in which to prepare the minds of students for the discussion of the subject of mental economy, which is the *raison d'etre* of this bulletin.

The labor of collating the returns was so great that it was found impossible to examine but 316 papers.[1] Care was taken, however, to select those which represented customs and practices in the different phases of university life, and it is doubtful if there would have been any special advantage in the examination of a much larger number; the conclusions regarding local manners and methods would probably not have been materially altered thereby

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[1] The statistical part of the work was done under my direction by Mr. F. J. Wojta.

CHAPTER III.

RELATIVE VALUE OF FOODS IN THE PRODUCTION OF NERVOUS ENERGY.

§1. *Philosophy of Nutrition.*—It is no doubt known to every one that the primary function of food in the system is to supply the force or forces required for the maintenance of the activities of life. The organism may be considered from this point of view as a mechanism designed to accomplish a certain amount of work, physical or mental; and in effecting this the energy represented in the thing done, including all accessory expenditures and waste, must balance that expended by the doer, thus conforming to the principle of the conservation of energy. The work thus required to be performed by every organism and entailing dissipation of vital energy may be regarded as of two kinds; in the first place the body must be kept up to a temperature quite above that of the environment in which it is ordinarily placed, and a large amount of force must therefore be transformed into heat. Then there is in every instance, though differing with different people, a characteristic amount of energy employed in muscular and mental activity. In these two directions force is being constantly utilized, and it must be as constantly replenished by the processes of nutrition if life is to be maintained

The factor of heat seems to be a practically uniform one for all people, since if in any case the body fall far below a certain standard the delicate adjustments essential for the perpetuation of the organism are disturbed and physical annihilation ensues. And by virtue of a comprehensive law of being, whereby all possible effort will be made to prevent the dissolution of life, the organism will strive in every way to supply the necessary energy for the preservation of normal temperature; and when needed it will draw upon the credit of the muscular and nervous systems, since one can survive with a relatively small amount of either motor or mental action. When, then, it may be remarked by the way, the body is not properly protected in cold climates, the energy which is generated in the system will be dissipated in comparatively large ratio in the effort to keep warm; and, as a consequence, less force can be utilized in the kinds of work for which in reality the organism exists; for in the highest forms of life, whatever may be true of those lower in the scale of existence, the ultimate purposes of existence are very clearly of a mental order. And in the attainment of these, motor processes are for the most part essential. So that in man mental and motor activities are of primary importance, regarded from the point of view of the *raison d'etre* of the organism, as well as from the testimony of introspection and of the desires of the human heart.

In addition to the purposes of nutrition already indicated there should be mentioned one other. In a growing structure, where continual increase in size and weight is taking place, there are required nutritive substances other than those utilized in carrying forward somatic and psychical functionings. There are needed substances for augmenting the bulk of bone and nerve and muscle,—materials for construction, that is to say. In adult life, however, when growth has been completed, there is no longer a demand for materials to build up, but only to repair the wear and tear of mind and body; so that in maturity we may take account principally of the requirements of the organism for the generation of force employed in the prosecution of mental and motor enterprises.

To return to our first proposition, the energy demanded to sustain the activities of life must be supplied in the food stuffs which are eaten. Now it is probably well known that various food elements are required to meet the different needs of body and brain. The nutrients best suited to furnish the materials employed in making bone and muscle are not alone sufficient to promote either muscular or mental action; and those adapted to supply physical power in largest measure are not in all cases the ones from which to gain cerebral energy most advantageously, as will be demonstrated more fully later. It should be noted here, however, that we say *just the ones,* for in some degree the energy of the entire organism may on occasion be drawn upon for the maintenance of either mental activity, motor activity, or temperature. This is indicated in the fact that arduous manual labor lessens the vigor, keenness, and duration of intellectual processes,[1] and reduces the temperature of the body. And in the same way intense and long continued mental application reduces the power of motor execution,[2] and, as in muscular labor, makes heavy demands upon the calorific condition of the system.[3] Spencer[4] called attention to this some time ago, and insisted that excessive brain work was causing physical deterioration in the English people. Mosso[5] maintains that severe brain work makes so great a demand upon the energies of the body that the muscles sacrifice a part of their albuminous constituents that mental activity may be sustained.

And yet there is a limit to the convertibility of the energies of the organism. One may be in good flesh and yet be undernourished nervously. Warner,[6] in his inspection of the school children of London, has frequently found instances where there was every evidence of adequate bodily nourishment, and yet nerve signs revealed a depleted condition of the brain. A few years ago there came under my observation in the city of Buffalo two children who gave their teachers and parents much trouble on account of their irritability and the slow progress they made in their studies. They appeared outwardly to be well nourished; but finally upon expert examination it was found that the blood was deficient in the elements required for adequate cerebral nutrition, and a special diet was resorted to. In a few weeks the children had noticeably improved in their emotional activities and in their intellectual work.

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[1] Curtis, Pedagogical Seminary, Vol. VI. VI, No. I, p. 78, quotes Mosso as saying that he has several times climbed to the top of Mount Blanc, but he can remember nothing of the view. He has a friend who has to write down his impressions on his way up or he can retain nothing.

[2] Mosso loc. cit.

[3] See an instance of lack of sleep causing marked fall in temperature. Pedagogical Seminary, Vol. VI, No. 1, p. 81.

[4] *Education*, p. 260 et seq.

[5] Loc. cit.

[6] *Mental Faculty*, pp. 79–80.

While, then, the production of energy for mental activity is, for the most part, simply one phase of the general problem of generating force for all the needs of the organism—the brain drawing its quota out of the common stock—yet in some measure this demands particular consideration. At the same time we must recognize with Warner,[1] that one probably never finds a vigorous brain in a starved body; so that in aiming to produce cerebral energy we must see to it that the organism *in toto* is well provided for, which requires that we consider the subject of nutrition as a whole.

It seems almost superfluous to say that the ideal dietary is one which will just meet the needs of the organism; it will not supply more nor less nutrition than can be profitably utilized. Overeating results in burdening the system, and so limiting its efficiency; undereating fails to supply fuel enough to keep the machinery of life in motion. There should indeed hang over each man's table the motto, "Eat to live, so that every power will be at its best;" and if this be made the rule of life one's board will afford the foods which his occupation specially demands. If he be an outdoors-man he must have more constructive and calorifacient material than if he live a sedentary life. If he be a student, fond of vigorous physical exercise for a few hours during the day, he will need to make more prominent in his dietary the reparative and heat-affording foods than will his lethargic, inactive classmate. When these individual needs are not recognized and the same regimen is provided for all with little opportunity for selection, then plainly some must suffer; there will be those who will be either overfed or underfed.

It has already been indicated that different food-stuffs contain different nutritive elements, and in order to secure proper nutrition they must be combined with one another in such a manner as to preserve right proportions between them in ministering to the needs of the organism, no matter whether we depend upon appetite, chemical analysis, or custom as our guide; a point which will receive fuller discussion in another place. The principal constituents of foods are: fats, carbohydrates, albumen (or protein), and salts;[1] and the uses to which each of these are put in building up, repairing, and sustaining mental and motor activity are satisfactorily stated by Church,[2] whose treatment of the subject may here be adopted.

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[1] Op. cit., p. 79.

CLASS I.—NUTRIENTS.

Division 1.—Incombustible Compounds.

Group i. Water—The carrier of nutritive materials and waste products; forms an essential part of all tissues; is present in large proportion where change is most active.

Group ii. Salts or Mineral Matter, such as common salt and phosphate of lime, which serve to effect changes and build up certain tissues.

Division 2.—Combustible Compounds.

Group iii. Carbon Compounds, such as starch, dextrin, sugar, and fat, which serve to keep up the heat and movements of the body by the discharge of their potential energy during oxidation in the organism. The fat of the body is formed in part from fat or oil in the food. The members of this group are often called "heat-givers," a term which is equivalent to "force-producers."

Appendix to Group iii. Gum, mucilage, and pectose, approach starch in chemical composition, and probably serve the same end. Cellulose may be named here, but its value as a nutrient is doubtful.

Group iv. Nitrogen Compounds, such as albumen, myosin, and casein, the chief formative and reparative compounds of food; they also may yield fat, and by their oxidation set free heat and motion. They are often named "flesh-formers," while the group is known as albuminoids.

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[1] Martin, Human Body, chap. XXI, employs a more detailed classification, but it is common now among writers on dietetics to speak only of the four great classes of nutritive elements, and this will be deemed sufficiently detailed for our purposes.

[2] *Food*, p. 9, (London, 1889, Chapman and Hall).

Appendix to Group iv. The ossein of bones and gelatin; cartilage and chondrin; keratin and elastin from skin and connective tissue,—approach the albuminoids in composition, and may serve in a measure, some of the same purposes in the body as those to which the true albuminoids are applied. This series of compounds may conveniently be designated the osseids.

CLASS II.—FOOD ADJUNCTS.

Group i. Alcohol, as contained in beers, wines, and spirits.

Group ii. Volatile or Essential Oils, and other odorous and aromatic compounds, as contained in condiments, like mustard and pepper, and in spices, as ginger and cloves.

Group iii. Acids, as citric acid in lemons, malic in apples, tartaric in grapes, oxalic in rhubarb, and acetic in vinegar and pickles.

Group iv. Alkaloids, as caffeine in coffee and tea, theobromine in cocoa, and nicotine in tobacco.

§2. *Statistical Summary of Studies on Foods.*—With this word upon the subject of nutritive values in general the returns from the questionnaire relating to food may be presented. The figures denote the number of times the various dishes were eaten, in a single week, and indicate simply the *relative* frequency with which certain articles of food are found in our students' dietaries. From an examination of the tables and individual diet lists it will become evident, and this is a point worth noting early, that brain workers in our community have set before them substantially the same bills of fare that manual laborers do, or that they discussed themselves when they were upon the farm, living an active out-door life.

The different articles of food arranged according to their relative frequency in dietaries are given below. The returns do not indicate the precise days of the year upon which records were made; but it may be sufficiently definite to know that the blanks were distributed on March 23, and were all returned by April 27:

Breakfast.

	Kind of Food.	No. Times Served.		Kind of Food.	No. Times Served.
1	Oatmeal	1,380	14	Porksteak	233
2	Bread, white	1,189	15	Rice	145
3	Coffee	1,088	16	Pie	104
4	Eggs, fried	812	17	Biscuits, white	78
5	Fruit	757	18	Mutton	78
6	Butter	752	19	Fish	78
7	Milk	704	20	Tea	62
8	Beefsteak	677	21	Veal chops	59
9	Potatoes, fried	646	22	Corn cake	58
10	Potatoes, baked	586	23	Potatoes, mashed	52
11	Toast	536	24	Sausage	38
12	Graham, bread	442	25	Eggs, poached	27
13	Pancake	298	26	Rye, bread	12

Dinner.

	Articles of Food.	No. Times Served.		Articles of Food.	No. Times Served.
1	Bread, white	1,067	18	Corn	199
2	Milk	844	19	Cranberries	195
3	Vegetables	716	20	Eggs, fried	188
4	Potatoes, fried	700	21	Peas	183
5	Fruit	688	22	Tea	182
6	Bread, graham	683	23	Potatoes, mashed	176
7	Pie	604	24	Veal, boiled	172
8	Roast beef	588	25	Beefsteak	164
9	Roast pork	440	26	Preserves	150
10	Pudding	431	27	Fish, fried	149
11	Cake	375	28	Mutton	147
12	Coffee	356	29	Ice cream	131
13	Sauce	333	30	Cheese	127
14	Potatoes, baked	288	31	Crackers, soda	115
15	Roast chicken and turkey	219	32	Salmon	88
16	Soup	215	33	Tongue	54
17	Beans	200	34	Oysters	41

Luncheon.

Articles of Food.	No. Times Served.	Articles of Food.	No. Time Served.
1 Bread, white	913	19 Biscuits	217
2 Potatoes, fried	660	20 Pudding	186
3 Milk	650	21 Crackers, soda	186
4 Cake	636	22 Toast	186
5 Bread, graham	594	23 Sausage	180
6 Potatoes, baked	552	24 Chocolate	174
7 Sauce	535	25 Oysters	174
8 Fruit	516	26 Chicken and turkey	172
9 Vegetables	468	27 Soup	166
10 Cold ham	417	28 Fish	160
11 Eggs, fried	402	29 Strawberries	155
12 Tea	401	30 Potatoes, mashed	155
13 Butter	389	31 Mutton	134
14 Coffee	388	32 Ice cream	131
15 Roast beef	255	33 Roast pork	111
16 Pie	253	34 Tongue	68
17 Beefsteak	247	35 Honey	17
18 Preserves	222		

Samples of the bills of fare served in the various places where students obtain meals are offered to show individual differences, and to be used later in computing the nutrient value of these typical rations.

Club Board—Questionnaire No. 1101.

Breakfast.		Luncheon.		Dinner.	
Oatmeal	4	Potatoes, fried	7	Meats—Chicken, roast	1
Pounded wheat	2	Hash	2	Beef, boiled	3
Coffee	7	Beef, boiled	3	Pork, boiled	2
Pork, fried	3	Veal, fried	2	Veal	1
Roast beef	4	Milk	7	Potatoes, boiled	7
Eggs and ham	1	White bread	7	Lettuce	4
White bread	5 or 6	Cake and sauce	4	Cabbage, boiled	3
Graham bread	2	Cabbage, boiled	3	Bread, white	3 or 4
Potatoes	2 or 3	Fried eggs	3	Corn, boiled	3
Milk	2 or 3	Butter	7	Milk	7
Wheat flour cakes	1	Strawberry shortcake	3	Pie	5
				Pudding	2
				Biscuits and honey	2

Private Board—No. 1526.

Breakfast.		Luncheon.		Dinner.	
Oatmeal, cooked 20 minutes.		Wiener wurst.		Bread and butter.	
Beefsteak	4	Milk.		Sugar.	
Pancakes	1	Fried Pork.		Corn.	
Bread and butter.		White bread.		Lamb	1
Milk, Water.		Sauce.		Mutton	1
Sugar.		Cake.		Chicken	1
Salt.		Eggs, occasionally.		Soup	1
Mustard.		Sauerkrout.		Tomatoes, occasionally.	
		Butter.		Sugar.	
		Lettuce, occasionally.		Salt.	
		Water.		Pepper.	

Restaurant—No. 1440.

Breakfast.		Luncheon.		Dinner.	
Oatmeal	7	Potatoes	7	Soup	2
Biscuits	7	Coffee	7	Boiled beef	6
Wheat bread	7	Cold beef	2	Fish	1
Eggs	3	Eggs	2	Potatoes	7
Pancakes	1	Hash	1	Gravy	7
Coffee	7	White bread	7	White bread	7
Sugar	7	Graham bread	4	Brown bread	5
Roast pork	2	Rye bread	3	Rye bread	3
Roast beef	2	Sugar	7	Pie	5
Graham bread	2	Butter	7	Beans	1
Fried cakes	3	Apples	3	Kraut	1
Potatoes	7	Bananas	3	Tomatoes, boiled	2
Butter	7	Oranges	1	Parsnips	1
				Cheese	1
				Lettuce	1

Ladies' Hall—No. 1027.

Breakfast.		Luncheon.		Dinner.	
Coffee	7	Milk toast	1	Parsnips, fried	7
Toast	5	Cold beef	1	Pickles	3
Potatoes, fried	2	Chicken, cold	1	Boiled beef	1
Beefsteak, fried	2	Ham	1	Beefsteak, fried	3
Ginger bread	2	Cheese	1	Lettuce	1
Sauce	1	Strawberries	2	Tomatoes	1
Eggs, poached	1	Cake	5	Pie	1
Doughnuts	1	Tongue	1	Cheese	1
		Potatoes, fried	2	Canned peas	1
		Radishes	1	Chicken, fried	2
		Honey	1	Sauce	3
		Milk	7	Potatoes, boiled	1
		Sauce	7	Bread	2
		Hot breads	3	Butter	7
		Cold breads	4	Ices and creams	2
		Olives	1	Cake	2
		Chocolate	7	Pudding	2
		Butter	7	Fruit and cream	1
		Corn	1	Beans	1
				Onions	1

Meats not very well done. Bread neither heavy nor light, but rather medium.

The articles of food which are actually eaten most largely are indicated in the answer to the question, What foods really form the substance of your dietary? One hundred and nine answered meats and vegetables, without specifying the kinds of each. Eighty-five live principally on oatmeal, according to the returns; 85 on bread and butter; 80 on potatoes; 71 on eggs; 76 on roast beef.

§3. *Composition of the Food-stuffs Found in the Tables.*—In order to pass judgment upon the value of these dietaries, either as a whole or individually, it is necessary to know what nutritive ingredients the various articles mentioned afford. It is doubtless impossible to determine this exactly by any known methods of calculation, since the element of life in general and individuality in particular,[1] which cannot be precisely reckoned with in our present methods of scientific experiment, probably modify in some measure the value of a food as it might appear when subjected to chemical examination. But chemical analysis can ascertain with accuracy the composition of any food, and this has been relied upon for a long time as a measurably safe index to the worth of any article. It is certainly not an overstatement to say that it is a reasonably reliable and serviceable method of determination. Granting an unknown and indeterminable factor in estimating the nutritive value of any food, yet chemical analysis would enable us to say this much at least,—that there are certain things in which it would be impossible, considering the limitations of the human digestive apparatus, to get sufficient albuminous elements, for instance, to support active, vigorous life; while in others, if eaten exclusively or even largely, albumen would be gained in excess. In this way, though the formulas obtained from chemical analyses do not represent the exact value of milk, for instance, as it will be received by the stomachs of different persons, yet, to repeat, it does indicate the substances from which the several elements may be derived most easily and economically, and this will give enough play to individual preferences and idiosyncrasies in digestion and assimilation. It should be said, too, that while the organism requires a certain quantity of fats, carbohydrates, and albumen, yet the administration of these in pure form would not serve to properly nourish a person. The nutrition which they contain is yielded only when they are obtained in an organized state as they are found in nature in the fruits, seeds, etc., of plants and in the flesh of animals.

The composition of foods as given by various investigators, while differing in some cases in slight degree, are yet for all practical purposes identical. The most satisfactory analyses with which the writer is familiar are those made by Jordan,[1] Atwater,[2] Church,[3] Smith,[4] and Kellogg.[5] The tables by Atwater are given below:

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[1] Charts showing differences between individuals in digestive characteristics, for instance, are shown further along, in Chap. VI.

FOOD MATERIALS.	Refuse (bones, skin, shell, etc.).	EDIBLE PORTION.						
		Water.	*Nutrients.*					Fuel value of 1 pound.
			Total	Protein.	Fat.	Carbohydrates.	Mineral matters.	
Animal foods, as purchased.	*Pr ct.*	*Pr ct.*	*Pr ct.*	*Pr ct.*	*Pr ct.*	*Pr ct.*	*Pr ct.*	*Cal.*
Beef:								
Neck	20	49.6	30.4	15.6	14	....	.8	880
Shoulder	12.6	55.8	31.6	17	13.7	....	.9	895
Chuck rib	14.6	49.5	35.9	15	20.1	....	.8	1,125
Rib	21	38.2	40.8	12.2	27.9	....	.7	1,405
Sirloin	19.5	48.3	32.2	15	16.4	....	.8	970
Round steak	7.8	60.9	31.8	18	12.8	....	1	855
Side, without kidney fat	19.2	44.3	36.5	13.9	21.8	....	.8	1,180
Rump, corned	5	70.8	24.2	16.7	5.1	....	2.4	525
Flank, corned	12.1	43.7	44.2	12.4	29.2	....	2.6	1,460
Veal, shoulder	17.9	56.7	25.4	16.6	7.9	....	.9	640
Mutton:								
Shoulder	16.3	49	34.7	15.1	18.8	....	.8	1,075
Leg	18.1	50.6	31.3	15	15.6	....	.7	935
Loin	15.8	41.5	42.7	12.6	29.5	....	.6	1,480
Side, without kidney fat	17.3	44.2	38.5	14	23.7	....	.8	1,260
Pork:								
Shoulder roast, fresh	14.6	43	42.4	13.6	28	....	.8	1,435
Ham, salted, smoked	11.4	36.8	51.8	14.8	34.6	....	2.4	1,735
Chicken	38.2	44.6	17.2	15.1	1.2	....	.9	330
Turkey	32.4	44.7	22.9	16.1	5.9	....	.9	550
Eggs, in shell	13.7	63.1	23.2	12.1	10.2	....	.9	655
Fish, etc.:								
Flounder, whole	66.8	27.2	6	5.2	.3	....	.5	110
Bluefish, dressed	48.6	43	11.1	9.8	.6	....	.7	210
Codfish, dressed	29.9	58.5	11.6	10.6	.2	....	.8	205
Shad, whole	50.1	35.2	14.7	9.2	4.8	....	.7	375
Mackerel, whole	44.8	40.4	15	10	4.3	....	.7	365
Halibut, dressed	17.7	61.9	20.4	15.1	4.4	....	.9	465
Salmon, whole	35.3	40.6	24.1	14.3	8.8	....	1	635
Salt codfish	42.1	40.5	17.6	16	.4	....	1.2	315
Smoked herring	50.9	19.2	29.9	20.2	8.8	....	.9	745
Salt mackerel	40.4	28.1	31.5	14.7	15.1	....	1.7	910
Canned salmon	4.9	59.3	35.8	19.3	15.3	....	1.2	1,005
Lobsters	62.1	31	6.9	5.5	.7	.1	.6	135
Oysters	82.3	15.4	2.3	1.1	.2	.6	.4	40

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[1] Jordan: *Dietary Studies at the Maine State College in 1885*, published by Washington Government Printing Office.

[2] Atwater: *Foods: Nutritive Value and Cost*, Washington Government Printing Office.

[3] Church: *Food*, Chapman and Hall, London.

[4] Smith: *Foods*, D. Appleton & Co., New York.

[5] Kellogg: *Publications of the Laboratory of Hygiene of the Battle Creek (Mich.) Sanitarium.*

Composition of foods—continued.

FOOD MATERIALS.	Refuse (bones, skin, shell, etc.).	EDIBLE PORTION.						
		Water.	*Nutrients.*					Fuel value of 1 pound.
			Total	Protein.	Fat.	Carbohydrates.	Mineral matter.	
Animal foods, edible portion.	*Pr ct.*	*Pr ct.*	*Pr ct.*	*Pr ct.*	*Pr ct.*	*Pr ct.*	*Pr ct.*	*Cal.*
Beef:								
Neck	......	62	38	19.5	17.5	....	1	1,100
Shoulder	......	63.9	36.1	19.5	15.6	....	1	1,020
Chuck rib	......	58	42	17.6	23.5	....	.9	1,320
Rib	......	48.1	51.9	15.4	35.6	....	.9	1,790
Sirloin	......	60	40	18.5	20.5	....	.1	1,210
Round	......	68.2	31.8	20.5	10.1	....	1.2	805
Side, without kidney fat	......	54.8	45.2	17.2	27.1	....	.9	1,465
Rump, corned	......	58.1	41.9	13.3	26.6	....	2	1,370
Flank, corned	......	49.8	50.2	14.2	33	....	3	1,655
Veal, shoulder	......	68.8	31.2	20.2	9.8	....	1.2	790
Mutton:								
Shoulder	......	58.6	41.4	18.1	22.4	....	.9	1,280
Leg	......	61.8	38.2	18.3	19	....	.9	1,140
Loin	......	49.3	50.7	15	35	....	.7	1,755
Side, without kidney fat	......	53.5	46.5	16.9	28.7	....	.9	1,525
Pork:								
Shoulder roast, fresh	......	50.3	49.7	16	32.8	....	.9	1,680
Ham, salted, smoked	......	41.5	58.5	16.7	39.1	....	2.7	1,960
Fat, salted	......	12.1	87.9	.9	82.8	....	4.2	3,510
Sausage:								
Pork	......	41.5	58.8	13.8	42.8	....	2.2	2,065
Bologna	......	62.4	37.6	18.8	15.8	....	3	1,015
Chicken	......	72.2	27.8	24.4	2	....	1.4	540
Turkey	......	66.2	33.8	23.9	8.7	....	1.2	810
Eggs	......	73.8	26.2	14.9	10.5	....	.8	721
Milk	......	87	13	3.6	4	4.7	.7	325
Butter	......	10.5	89	1	85	.5	3	3,615
Oleomargarine	......	11	89.5	.6	85	.4	3	3,605
Cheese:								
Full cream	......	30.2	69.8	28.3	35.5	1.8	4.2	2,070
Skim milk	......	41.3	58.7	38.4	6.8	8.9	4.6	1,165
Fish:								
Flounder	......	84.2	15.8	13.8	.7	....	1.3	285
Haddock	......	81.7	18.3	16.8	.3	....	1.2	325
Codfish	......	82.6	17.4	15.8	.4	....	1.2	310
Shad	......	70.6	29.4	18.6	9.5	....	1.3	745
Mackerel	......	73.4	26.6	18.2	7.1	....	1.3	640
Halibut	......	75.4	24.6	18.3	5.2	....	1.1	560
Salmon	......	63.6	36.4	21.6	13.4	....	1.4	965
Salt cod	......	53.6	......	21.4	.3	....	1.6	410
Herring, salt	......	34.6	......	36.4	15.8	....	1.5	1,345
Mackerel, salt	......	43.4	......	17.3	26.4	....	2.6	1,360
Oysters	......	87.1	12.9	6	1.2	3.7	2	230

Composition of foods—continued.

FOOD MATERIALS.	Refuse (bones, skin, shell, etc.).	EDIBLE PORTION.						
		Water.	*Nutrients.*					Fuel value of 1 pound.
			Total	Protein.	Fat.	Carbohydrates.	Mineral matter.	
Vegetable foods.	*Pr ct.*	*Pr ct.*	*Pr ct.*	*Pr ct.*	*Pr ct.*	*Pr ct.*	*Pr ct.*	*Cal.*
Wheat flour	......	12.5	87.5	11	1.1	74.9	.5	1,645
Graham flour (wheat)	......	13.1	86.9	11.7	1.7	71.7	1.8	1,625
Rye flour	......	13.1	86.9	6.7	.8	78.7	.7	1,625
Buckwheat flour	......	14.6	85.4	6.9	1.4	76.1	1	1,605
Oatmeal	......	7.6	92.4	15.1	7.1	68.2	2	1,850
Corn meal	......	15	85	9.2	3.8	70.6	1.4	1,645
Rice	......	12.4	87.6	7.4	.4	79.4	.4	1,630
Peas	......	12.3	87.7	26.7	1.7	56.4	2.9	1,565
Beans	......	12.6	87.4	23.1	2	59.2	3.1	1,615
Potatoes	......	78.9	21.1	2.1	.1	17.9	1	375
Sweet potatoes	......	71.1	28.9	1.5	.4	26	1	530
Turnips	......	89.4	10.6	1.2	.2	8.2	1	185
Carrots	......	88.6	11.4	1.1	.4	8.9	1	200
Onions	......	87.6	12.4	1.4	.3	10.1	.6	225
String beans	.....	87.2	12.8	2.2	.4	9.4	.8	235
Green peas	......	78.1	21.9	4.4	.6	16	.9	405
Green corn	......	81.3	18.7	2.8	1.1	13.2	.6	345
Tomatoes	......	96	4	.8	.4	2.5	.3	80
Cabbage	......	91.9	8.1	2.1	.3	5.5	1.1	155
Apples	......	83.2	16.8	.2	.4	15.9	.3	315
Sugar, granulated	......	2	98	......	......	97.8	.2	1,820
Molasses	......	24.6	75.4	......	......	73.1	2.3	1,360
White bread (wheat)	.....	32.3	67.7	8.8	1.7	56.3	.9	1,280
Boston crackers	......	8.3	91.7	10.7	9.9	68.7	2.4	1,895

§4. *Composition and Value of Food Materials Not Found in the Dietary Lists.*—In addition to the composition of articles given in Atwater's tables should be mentioned that of other valuable foods. And we may look first at the familiar edible nuts which are sometimes found upon the tables of the well-to-do, but are generally regarded as a luxury suited to gratify the palate but not well adapted to sustain the activities of body or brain. The chemical composition of these nuts shows, however, that they are exceedingly rich in substances needed for the proper nutrition of the entire organism. The following analyses of these varieties of nuts which are easily obtained in our locality are taken from Church:[1]

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[1] Op. cit.

Chemical composition of nuts.

	Parts in 100	In 1 pound.	
		Oz.	Gr.
Composition of Chestnut-Kernels:			
Water	14.0	....	....
Albuminoids, etc	8.5	....	....
Starch	29.9	....	....
Dextrin	22.9	....	....
Sugar	17.5	....	....
Oil	1.3	....	....
Cellulose	3.3	....	....
Mineral matter	2.6		
Walnut Kernels:			
Water	44.5	7	53
Albuminoids	12.5	2	0
Mucilage, etc	8.9	1	185
Oil	31.6	5	24
Cellulose	0.8	0	56
Mineral matter	1.7	0	119
Filbert-Kernels:			
Water	48.0	7	297
Albuminoids	8.4	1	151
Oil	28.5	4	245
Mucilage, starch, etc	11.1	1	340
Cellulose	2.5	0	175
Mineral matter	1.5	0	105
Sweet Almonds (shelled):			
Water	6	0	420
Albuminoids, etc	25	4	0
Oil	54	8	280
Mucilage, etc.	9	1	192
Cellulose	3	0	210
Mineral matter	3	0	210
Pistachio-kernels:			
Water	7.4	1	80
Albuminoids, etc	22.7	3	277
Oil	51.1	8	77
Mucilage, etc.	13.0	2	35
Cellulose	2.5	0	175
Mineral matter	3.3	0	231
Cocoanut-kernels:			
Water	46.7	7	200
Albuminoids, etc.	5.5	0	385
Oil	35.9	5	325
Sugar, etc	8.1	1	130
Cellulose	2.9	0	203
Mineral matter	1.0	0	70
Ground or Pea Nuts (shelled):			
Water	7.5	1	87
Albuminoids, etc	24.5	3	403
Starch, etc	11.7	1	382
Oil	50.0	8	0
Cellulose	4.5	0	315
Mineral matter	1.8	0	126

Doubtless one reason why nuts do not constitute a more important part of our dietaries is found in the fact that they are all difficult of digestion by most people, while some of them, as the peanut in the form in which we ordinarily obtain it, are quite invulnerable to the attack of many stomachs. This objection need not longer be urged, however, since methods of preparing nuts have become so perfected that products are now on the market which will not trouble the most delicate digestive apparatus, and which are at the same time highly nutritious. These preparations present the nutritive elements in nuts in a variety of forms, most of them resembling closely in general appearance and consistency the products of milk. The terms given the different varieties indicate this,—nut butter, nut cream, and the like. The composition of the nut foods manufactured at Battle Creek, Mich., are given below:

	Proteids.	Fats.	Carbo-hydrates.
Malted Nuts	23	20.4	49.3
Nut meal	26	52	19
Nut butter	24	52	19
Bromose	19.6	24	39.4
Maltol	0	20	75

From an economical standpoint they probably furnish more nutrition for money expended than meat and butter, as substitutes for which in whole or in part they are especially well adapted. They are highly esteemed by some hygienists, notably by Kellogg, since, it is said, they furnish the necessary fat in a better form than it can be obtained in butter, or any animal fat which has become separated from the elements with which it is ordinarily combined. It is maintained by these authorities that butter cannot be assimilated in the condition in which it is eaten, but has to be converted back into cream, that is emulsified, before it can be utilized in the system. There is involved here a general principle of nutrition which has been alluded to elsewhere,—that elementary substances in the pure state cannot be incorporated into the system, while they can without trouble when organized in the natural way in plant or animal life. But however this may be it is certain at any rate that the nut products afford palatable and at the same time exceedingly nutritious and readily assimilable articles of food; and they might well have a prominent place in a student's dietary since it is of the greatest importance that he should, particularly in the morning meal, gain abundant nutrition in the readiest and most agreeable way possible.

There are other food materials which should be mentioned in this place before passing to consider the nutrient values of the dietaries appearing in our statistical summary. These are, in the first place, the preparations of grains wherein a certain proportion of the carbohydrate ingredients have been removed and all or most of the albuminous elements retained. Some of them are known in the market as Granola, Granose, Malt Breakfast Food, Ralston Breakfast Food, Purina, Health Flour, et al. The composition of these foods shows that they contain a higher percentage of proteid elements than the flours and breads presented in Atwater's tables.

Hoffman, chemist at the State Agricultural and Mechanical College of South Carolina, has analyzed Purina Health Flour, and found that it contained:

Water	14.0 per cent.
Proteids	14.9 per cent.
Carbohydrates	66.2 per cent.
Fat	1.6 per cent.
Fibre	1.6 per cent.
Mineral matter	1.7 per cent.

An analysis of Malt Breakfast Food, made by the government chemists at Washington, under the direction of Prof. H. W. Wiley, gives the following:

Proteids	11.63
Carbohydrates	77.00
Fats	1.75
Ash	1.05
Water	7.85
Lignose and cellulose	.73

Germos, as analyzed by the manufacturers, contains 20 per cent. of albumen, 1.5 per cent. of fat, 62 per cent. of starch, and 1 per cent. of salts. Granola is said to contain a still higher percentage of albumen, although I have not been able to secure an analysis showing its exact composition. Granola and Malt Breakfast Food are distinguished in another way, in that the starch they contain is partially digested during the process of manufacture by the application of heat in the first case and by malting in the second, which convert it into certain varieties of dextrin, a point which will be considered more fully later in discussing the modes of preparing food. This predigestion of the starch renders such foods much more palatable and delicious than the ordinary uncooked article. It may be remarked here, too, that in view of the fact that the ease with which a food can be made to yield the energy it contains is perhaps the most important factor in the determination of its nutritive value, at least for one engaged in mental labor, it can be seen that the foods just mentioned are far superior to those generally found in the dietary lists of our students.

§5. *The Nutrient Value of Student's Dietaries,—Estimates and Comments.*—What now about the dietaries submitted in response to our questionaire? In order to determine their value in a complete and scientific manner one should have ascertained the precise quantity of each dish eaten, its exact composition, and the digestive peculiarities of each individual; and these data could be obtained only with great difficulty, if indeed they could be secured at all. But (and this has been said already) there was at the outset no intention of making an elaborate and detailed study of local conditions, so that the facts in hand are sufficient to warrant the general suggestions which will be offered.

In estimating the value of a dietary one must know, in the first place, how much energy a person could profitably expend in his daily activities and what amount and variety of food is necessary to supply this. It has been calculated that a man engaged in active muscular work expends energy equal to about 150,000 metre-kilograms or 4,000 calories, a calorie representing the amount of heat required to raise one gram one degree Centigrade.[1] While it has not been possible, so far as I know, to determine the precise amount of energy expended by a student engaged in severe mental labor, yet one is warranted in assuming that it is not far below that indicated for a man employed in muscular pursuits,[2] and it is not incredible that it should be greater.

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[1] Stevenson & Murphy, *Treatise on Hygiene*, Vol. I, p. 401.

[2] See, for instance, Sargent, North American Review, May, 1897.

To supply the energy required for all the needs of the organism during a day's activities, authorities agree substantially upon the quantity of the various food materials necessary, although the standards calculated for Germany and America are somewhat different, the American being considerably higher, probably due to the fact that our people are more active than the Germans, and are constantly expending more energy, possibly a good part of it going to waste. Atwater[1] gives the American and European dietary standard as follows:

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[1] Op. cit., p. 18.

American and European dietaries and dietary standards.

[Quantities per man per day.]

DIETARIES.	NUTRIENTS.			Fuel values.	Nutritive ratio.*
	Protein.	Fats.	Carbohydrates.		
American (Massachusetts and Connecticut.)	*Lbs.*	*Lbs.*	*Lbs.*	*Cal.*	*1:*
Family of carpenter in Middletown, Conn	.25	.28	.76	3,055	5.5
Family of glass-blowers in East Cambridge, Mass	0.23	0.29	1.06	3,590	8.2
Boarding house, Lowell, Mass.; boarders, operatives in cotton mills	.29	.44	1.21	4,650	7.6
Boarding house, Middleton, Conn., well-paid machinists, etc., at moderate work: Food purchased	.28	.41	.94	4,010	6.8
Boarding house, Middleton, Conn., well-paid machinists, etc., at moderate work: Food eaten	.23	.34	.84	3,490	7.3
Blacksmiths, Lowell, at hard work	.44	.67	1.75	6,905	7.4
Brickmakers, Massachusetts; 237 persons at very severe work	.40	.81	2.54	8,850	11
Mechanics, etc., in Massachusetts and Connecticut; average of 4 dietaries of mechanics at severe work	.48	.65	1.65	6,705	6.6
Average of 20 dietaries of wage-workers in Massachusetts and Connecticut	.34	.50	1.38	5,275	7.5
Average of dietaries of professional men and college students in Middletown, Conn: Food purchased	.30	.36	1.12	4,140	6.6
Average of dietaries of professional men and college students in Middletown, Conn: Food eaten	.27	.34	1.08	3,925	6.6
European (English, German, Danish, and Swedish).					
Well-fed tailors, England, Playfair	.29	.09	1.16	3,055	4.7
Hard-worked weavers, England, Playfair	.34	.09	1.37	3,570	4.8
Blacksmiths at active labor, England, Playfair	.39	.16	1.47	4,115	4.7
Mechanic, Munich, 60 years old, in comfortable circumstances, light work, Forster	.26	.15	.76	2,525	4.3
Well-paid mechanics, Munich, Voigt	.34	.12	1.06	3,085	4
Carpenters, coopers, locksmiths, Bavaria; average of 11 dietaries, Voit	.27	.08	1.28	3,150	5.3
Miners at severe work, Prussia, Steinheil	.30	.25	1.40	4,195	6.7
Brickmakers (Italians), Munich, diet mainly maize meal and cheese, severe work, Ranke	.37	.26	1.49	4,540	5.6
German army ration, peace footing	.25	09	1.06	2,800	5
German army ordinary ration, war footing	.30	.13	1.08	3,095	4.6
German army extraordinary ration, in war	.42	.10	1.49	3,985	4.1
University professor, Munich; very little exercise, Ranke	.22	.22	.58	2,325	4.7
Lawyer, Munich, Forster	.18	.28	.49	2,400	6.3
Physician, Munich, Forster	.28	.20	.80	2,830	4.4
Physician, Copenhagen, Jurgensen	.30	.31	.53	2,835	4.1
Average of 7 dietaries of professional men and students, Germany, Denmark, and Sweden	.25	.22	.63	2,670	4.7
Dietary Standards.					
Adult in full health, Playfair	.26	.11	1.17	3,140	5.5
Active laborers, Playfair	.34	.16	1.25	3.630	4.7
Man at moderate work, Moleschott	.29	.09	1.21	3,160	4.9
Man at moderate work, Voit	.26	.12	1.10	3,055	5.3
Man at hard work, Voit	.32	.22	.99	3,370	4.7
Man with little physical exercise, Atwater	.20	.20	.66	2,450	5.5
Man with light muscular work, Atwater	.22	.22	.77	2,800	5.7
Man with moderate muscular work, Atwater	.28	.28	.99	3,520	5.8
Man with active muscular work, Atwater	.33	.33	1.10	4,060	5.6
Man with hard muscular work, Atwater	.39	.55	1.43	5,700	6.9

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* The nutritive ratio is the ratio of the protein to the sum of all the other nutritive ingredients. The fuel value of the fat is two and a quarter times that of the protein and carbohydrates. In calculating the nutritive ratio the quantity of fats is multiplied by two and one-fourth. This product is added to the weight of the carbohydrates. The sum divided by the weight of the protein gives the nutritive ratio. Materials with

It is probable that these standards should be somewhat modified for persons engaged in intellectual pursuits, greater emphasis being laid upon the albuminoids and fats, and less upon the carbohydrates; or, what is perhaps a juster way to put it, the proportion of carbohydrates should be somewhat less in the dietary of a student than that appearing in any of the tables given. This inference is based upon a point discussed in preceding paragraphs, wherein it was said that the nutrition of nerve cells is believed to demand albuminoids and fats in largest ratio.

Taking now any one of the individual dietaries already given, say No. 1526, it will be possible to estimate with a fair degree of accuracy its worth judged by the standards here presented. Of course, considering that the exact amount of food eaten has not been indicated makes it impossible to determine the value only in a general or inferential manner. Assuming, however, that the quantity of each article consumed would be approximately the same for students and other adults we may gain some impression of the value of our dietary by comparing it with others when the articles are substantially the same, and where the amounts of each eaten have been accurately obtained and the nutritive value calculated. Such a study has been made in Boston under the direction of Atkinson,[1] and his results are indicated below:

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large amounts of fats or carbohydrates and little protein, like fat meats or potatoes, have a "wide" nutritive ratio. Those with a large amount of protein as compared with the carbohydrates and fats, like lean meat, codfish, and beans, have a "narrow" nutritive ratio. In other words, the materials rich in tissue forming substances have a narrow, and those with a large preponderance of fuel materials have a wide, nutritive ratio. This is an important matter in the adjusting of food to the demands of the body.

A well-balanced diet is one which has the right ratio of protein to the fats and carbohydrates. A relative excess of the tissue formers makes the ratio narrow, while an excess of the fuel ingredients makes an overwide ratio in the diet. Either of these errors is disadvantageous. Our food materials and our diet are apt to have too wide a nutritive ratio. In other words, we consume on the whole relatively too little protein and too much of the carbohydrates and fats.

[1] Op. cit., p. 150.

Sunday, February 22, 1890.

BREAKFAST.

	Man.	Woman.
	Ounces.	*Ounces.*
Milk	4	6
Flour griddle cakes	2½	4
Syrup	¼	½
Butter	½	¼
Cheese	¼	¼
Cream	3	½
Coffee	10	8
Sugar	½	Taste.
Oatmeal	11½	5
Water	4	0
	36½	24½

DINNER.

	Man.	Woman.
Cold corned beef	3	1½
Fat beef	½	0
Vegetables, parsnip, beet, turnip	5½+	5
Baked potatoes	8½ + 1½ oz. waste	9½ + 2½ oz. waste
Bread	2	0
Butter	1	1½
Fruit	3½ + ½ oz. waste	4 + ½ oz. waste
Nuts	1	¼
Raisins	0	¼
Water	18	12
	79½	58½

SUPPER.

	Man.	Woman.
Pear sauce	5 + 1 oz. sugar.	5 + 1 oz. sugar.
Bread	1¼	1¾
Cookie	¾ + ½ oz. sugar.	0
Butter	¼	¼
Crackers at bedtime	1	0
Water	0	12
Milk	6	0
	99¾	71½
Less waste	5	5
	94¾	66½

Calculation of the above:

MAN.

	Grms. albumen.	Fats.	Sugar.	Starch.	Grms. Total.
Milk	4.5	3.9	4.5	....	112
Cream	2.5	10.1	2.5	....	84
Butter	0.4	32.9	....	....	38
Cheese	2.1	2.2	....	....	7
Bread	6 4	0 5	....	41.4	91
Beef	28.6	6.3	....	....	84
Sugar	89	....	54	....	56
Potato	2	....	....	41.2	196
Vegetables	....	....	15.4	....	154
Fat in beef	....	14	....	....	14
Griddle cakes	10.5	....	....	35.0	70
Oatmeal	11.2	5.6	....	50.8	322 (80 dry)
Cookies	....	....	....	....	18
Nuts	4.5	15	....	9.7	28
Fruit	1.4	1.5	17	....	196
Crackers	2.0	0.1	....	15.8	28
Calories 2,384	80.00	92.1	297.3		1,498

WOMAN.

	Grms. Albumen.	Fats.	Sugar.	Starch.	Grms. Total.
Milk	13.4	11.3	13.4	....	336
Cream	0.4	1.7	0.4	....	14
Butter	0.6	48.4	....	....	56
Cheese	2.1	2.2	....	....	7
Bread	3.4	0.3	....	27.7	49
Beef	14.3	3.2	....	....	42
Sugar	....	....	33.8	....	35
Potato	3 9	....	....	41.2	196
Vegetables	1.8	....	14	....	140
Fat beef	....	....	....	....	0
Griddle cakes	16.8	....	....	56.0	112
Oatmeal	4.9	2.5	....	22.2	140 (35 dry)
Nuts	1.1	3.7	....	....	7
Fruit	....	....	18.3	....	210
Calories 1,859	62.7	73.8	227.0		1,344

Since the dietary standard given by Atwater calls for at least 125 grams of albumen, 125 grams of fat, and 450 grams of carbohydrates[1] it can be seen that Atkinson's man and woman did not consume enough of nutritious food. While these dietaries are deficient in all the food elements, the deficiency would be especially marked in respect of protein and fats if the guests were students. It is probable that the same thing can be said of dietary No. 1526. If the person living on this bill of fare should consume enough of the articles mentioned to supply the requisite amount of albuminous nutrients he would probably overload the organism with carbohydrates and waste matters; although this can be said not as founded upon direct and conclusive, but only upon indirect and inferential, evidence. It is suggestive to note in this connection that many authorities[1] have advanced the opinion that American dietaries as a rule accord too prominent a place to carbonaceous foods, and if this be true of our people at large, it must be especially true of the food of students. The predominance in the dietary lists of our students of such carbonaceous foods (and they are regarded as carbonaceous since the ratio of carbohydrates to protein is greater than that required for perfect nutrition) as white bread, potatoes, griddle cakes, cabbage, beets, and the like, indicates that they are too highly esteemed, relatively speaking, in our own locality, as they are elsewhere.

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[1] Loc. cit.

Kellogg maintains that the proportion of albumen to carbohydrates in a model bill of fare should be as 1 to 7, while Atwater demands that the ration be much richer in protein, the desired proportion being, in his opinion, about as 1 to 3 or 4. Other estimates lie somewhere between these extremes,[2] the weight of testimony, however, seeming to declare that Atwater's formula would give too "narrow" a ration, and that the albuminoids should not constitute more than 1-6 or 1-7 of the quantity of the other foods. Now, the composition of the ordinary food materials shows that few of them contain an excessive amount of protein, while the bulk of them are deficient in this respect, as will appear from the following table:

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[1] For instance, Jordan, op. cit., p. 57; Atwater, op. cit., p. 18.

[2] For a good discussion of the question, see Stevenson & Murphy, *loc. cit.*

Proportion of nitrogenous to carbonaceous elements in various foods.

	Album. or Nitrog.	Carbonaceous.		Album. or Nitrog.	Carbonaceous.
Lean beef	1	.5	Indian meal	1	7.7
Eggs	1	1.9	Rye meal	1	9.8
Peas	1	2.7	Potatoes	1	10.7
Beans	1	2 7	Carrots, and other vegetables (averaging)	1	11.0
Lentils	1	2.4	Barley meal	1	12.7
Milk	1	3.6	Rice	1	13.0
Fat beef	1	5.0	Common fruits (averaging)	1	80.0
Oatmeal	1	6.1			
Whole wheat meal or bread	1	7.0			

The quantities of some of the familiar foods which must be consumed daily in order that the required amount of protein may be obtained are shown below. The table gives warrant for the assertion that one whose dietary consists almost wholly of fruits, vegetables, white bread, tea and coffee can hope to gain but little more than enough nutrition to keep body and soul together.

Amounts of various foods necessary to furnish the proper daily amount of albuminous elements.

	Ounces.		*Pounds.*
Lean meat	15.6	Apples	99⅛
Eggs	21.2	Peaches	50.0
Peas	11.2	Plums	99⅛
Oatmeal	23.6	Cherries	22.0
Baker's bread	36.7	Carrots	15.0
Wheat flour (fine)	27.5	Turnips	16.0
Graham flour	25 5	Cabbage	22.0
Indian meal	26.3	Parsnips	18.0
Rye meal	37.1		*Pints.*
	Pounds.	Milk	4.5
Rice	3.0	Beer	185.0
Potatoes	8.8	Tea—Over 2⅛ lbs. dried leaves or 192 pints of strong infusion.	
Grapes	24⅜	Coffee—About 3 lbs. of dried berries.	

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The too great proportion of carbohydrates and waste materials in some of our students' bills of fare could be balanced in a pleasing and economical manner by using more largely the pulse foods, as beans, peas and lentils; nut products, as nuttose, malted nuts, and protose; and substituting, at least in part, whole wheat bread made from such flour as the Purina Health Flour for the variety found so exclusively upon the tables in our community. And it should be pointed out especially that whole wheat bread and graham bread are not the same article, either in respect of nutritive value or readiness and ease of digestion. The graham bread with which we are all familiar contains the outer husk of the wheat kernel, which cannot be assimilated, and which seems to accomplish little else than to irritate the digestive tract. Whole wheat flour, on the other hand, possesses the great advantage of having the fibrous covering removed while preserving all of the albuminous part of the kernel. In the ordinary white bread, however, a large fraction of the albuminous part of the wheat is removed in milling. Church discusses this point so satisfactorily that I may quote his words:[1]

"There are two parts of the wheat grain which, in various milling processes, are often removed. One of these is the germ, the other is the outermost coat of the grain. The germ is removed in roller-milling, because its presence tends to discolor the flour, and gives it a marked tendency, especially when kept under unfavorable conditions, to acquire a rancid taste and odor. That the exclusion of the germ is to be regretted on dietetic grounds is evident when its singular richness in oil, in nitrogenous matters, and in phosphoric acid, is considered. The following analysis was made on a pure sample of flattened germs from a roller-mill:—

	In 100 parts.
Water	12.5
Albuminoids, diastase, etc	35.7
Starch, with some dextrin and maltose	31.2
Fat or oil	13.1
Cellulose	1.8
Mineral matter	5.7

More than half this mineral matter was phosphoric acid; indeed, it amounted to no less than 60.6 per cent. of the total ash, so that the original embryos contained nearly 3½ parts per hundred of this valuable constituent of bone. The nitrogenous matters amounted to thrice the proportion present in the whole wheat grain; the oil or fat was more than six times as much. It should be added that the albuminoid matter included little or no tenacious gluten, but a considerable quantity of the diastatic ferment.

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[1] Op. cit., p. 70.

"But if, on some grounds, the exclusion of the germ from our mill-products is a procedure of doubtful utility, there can be no question that the removal of the fibrous outer envelope of the grain is of considerable advantage. The following figures were obtained in the analysis of a carefully prepared sample:—

	In 100 parts.
Water	15.2
Albuminoids (from total nitrogen)	10.4
Oil	2.5
Ash or mineral matter	2.6

To these analytical results it may be added that this ash contained no more than 15.3 per cent. of phosphoric acid. All these results, and the high proportion of fiber present, contrast very strongly with those previously given in the analysis of the germ."

If now one desired to work out his daily dietary so as to obtain the right proportions of albuminous and carbonaceous elements with something like mathematical accuracy, which process, if it demanded his constant attention and made him over-conscious of his food, would certainly be an unwise proceeding;—but if he wished to do it, he might proceed according to the following scheme (Kellogg):

Combine 8 ounces lean beef.......with 4 pounds 8 ounces potatoes.
Combine 7½ ounces lean beef.......with 1 pound 8 ounces rice.
Combine 1½ ounce lean beef.......with 1 pound 8 ounces Indian meal.
Combine 12 eggs......................with 1 pound 6 ounces rice.
Combine 9 eggs......................with 5 pounds 2 ounces potatoes.
Combine 3 pints of milk...........with 1 pound of rice.
Combine 2½ pints of milk...........with 4 pounds 4 ounces potatoes.
Combine 7½ ounces peas ....with 1 pound 4 ounces rice.
Combine 6 ounces peas............with 5 pounds of potatoes.
Combine 5 ounces oatmeal ....with 5 ounces rice.
Combine 4 ounces oatmeal ....with 1 pound 11 ounces potatoes.
Combine 4 ounces oatmeal ....with 5 ounces rye meal.
Combine 15 ounces oatmeal ....with 10 ounces Indian meal.

A word should be said of the heat-producing properties of foods, since the extremes of climate in these regions make this a very important matter. Yet it is almost entirely disregarded by the makers of bills of fare in our midst. Fats have as prominent a place on our tables in mid-summer as in mid-winter; there seems to be a sort of stereotyped form that is used all the year round. But the organism loaded with calorifacient foods in our hottest weather is obviously at a great disadvantage; just as is one deprived of a liberal allowance of them in January or February. Landlords should know something of the calorific qualities of different articles, such information, for instance, as that presented in the accompanying chart, and they should take into account the standing of the thermometer when constructing a bill of fare.

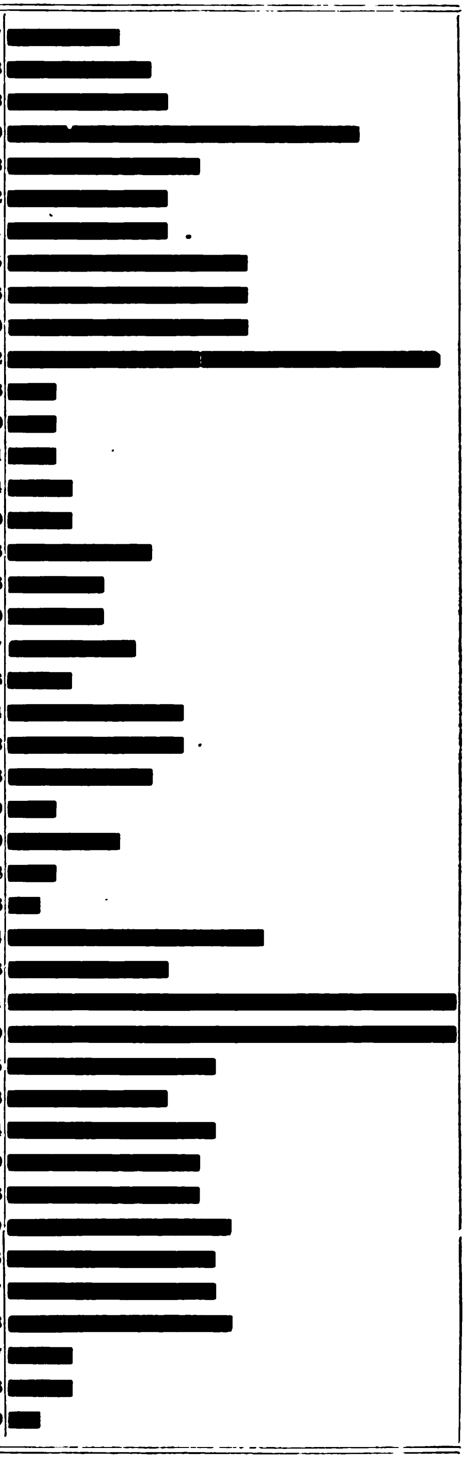
So much has been said regarding the evil of making carbohydrates too prominent in one's dietary that a word is demanded respecting the tendency in some cases of consuming more albumen in the daily ration than the organism can utilize. This is liable to be the case where one eats heartily of lean meat three times a day, while at the same time not reducing the amount of other substances rich in protein. Suppose that one eats five ounces of lean beef at each of three meals, he will obtain 4.45 ounces of protein, the maximum amount for a man engaged in active labor, mental or physical. Then if he add bread, peas, milk, puddings, and nuts, he will convey into his system a considerable quantity of albumen that will have to be eliminated unused; and it seems reasonable to suppose that the working capacity of the organism will be in so far reduced. Overeating in this way must be regarded as lessening the efficiency of the organism in somewhat as serious a sense perhaps as undereating.

An examination of dietary No. 1101 shows that meat was eaten three times every day for a week, and to this were added each day a cereal rich in albumen, besides bread, milk, corn, eggs, and other articles. Now, if this guest ate heartily of meat at each meal, it is practically certain that he consumed more protein than he could utilize, and it must consequently have been a hindrance rather than a help to him. Everyone is doubtless familiar with the opinions of physicians to the effect that sed-

Chart showing calories in the nutrients in one pound of each food material.

(Atwater.)

Beef, round, rather lean	807
Beef, neck	1,108
Beef, sirloin, rather fat	1,173
Beef, flank, very fat	2,750
Beef, side, well fattened	1,463
Mutton, leg	1,142
Mutton, shoulder	1,281
Mutton, loin (chops)	1,755
Mutton, sides, well fattened	1,906
Smoked ham	1,960
Pork, very fat	3,452
Flounder	286
Cod	310
Haddock	331
Bluefish	404
Mackerel, rather lean	430
Mackerel, very fat	1,026
Mackerel, average	696
Shad	750
Salmon	967
Salt cod	416
Salt mackerel	1,364
Smoked herring	1,343
Canned salmon	1,036
Oysters	229
Hen's eggs	760
Cow's milk	308
Cow's milk, skimmed	176
Cheese, whole milk	2,044
Cheese, skimmed milk	1,166
Butter	3,691
Oleomargarine	3,679
Wheat flour	1,655
Wheat bread	1,278
Rye flour	1,614
Beans	1,519
Peas	1,476
Oatmeal	1,830
Corn (maize) meal	1,616
Rice	1,627
Sugar	1,798
Potatoes	427
Sweet potatoes	416
Turnips	139



entary people especially should eat sparingly of meat if they are generous in their daily allowance of other protein-bearing foods,[1] since elimination is a relatively serious matter for those who are not active muscularly much of the time. Many believe, and it seems with a show of reason, that sedentary people should get their albuminous foods in some other substances, for the most part, than meat, since all flesh contains worn out products that have not been eliminated in the life of the animal, and that are not only valueless for the purposes of nutrition, but are moreover a sort of drug in the system. A student eating a large amount of beefsteak, for instance, from which the blood has not been thoroughly drawn, and not exercising a great deal, cannot but be handicapped in mind and body, since his organism must become clogged up with the toxic products of his own activities and of those of the animal which he imports into his system.

§3. *Specimen Dietaries Fulfilling the Requirements of Adequate Nutrition.*—In view of what has been presented in preceding sections it may be instructive now to show in actual bills of fare how the principles which have been advanced can be embodied in practice. Atwater, Atkinson, Kellogg, and others have constructed dietaries indicating the required daily amount of each article of food which in the total will give the right quantity of the several nutrient elements. The food materials used in these dietaries are substantially such as constitute the body of the bills of fare of our students; and while some of these could with great advantage be banished from our tables and other articles substituted in their stead (for instance, nut foods taking the place of pork in every form, and much of the other flesh, cream being used more largely in the place of butter, the nitrogenous cereals discussed in §4 being added to the lists, etc.), yet it will be well to see what can be done with those things, valueless as some of them are, that tradition keeps in the diet lists of students as of other people. In the case of Atwater's tables the cost is given, and this will be referred to later.

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[1] See The North American Review, Vol. 164, p. 664, for expert opinion upon this subject.

Daily dietaries—Food materials furnishing approximately the 0.28 pound protein and 3,500 calories of energy of the standard for daily dietary of a man at moderate muscular work.

Food materials.	Amount.	Cost.	NUTRIENTS.				Fuel value.
			Total.	Protein.	Fats.	Carbohydrates.	
	Ounces.	*Cents.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Calories.*
Beef, round steak.	13	11.40	.26	.14	.12	....	695
Butter	3	5.65	.16	....	.16	....	680
Potatoes...	6	1.25	.17	.02	....	.15	320
Bread..............	22	5.50	.89	.12	.02	.75	1,760
	44	23.80	1.48	.28	.30	.90	3,455
Pork, salt..........	4	8	.21	....	.21	....	880
Butter	2	3.75	.11	....	.11	....	450
Beans..............	16	5	.84	.23	.02	.59	1,615
Bread..............	8	2	.33	.04	.01	.28	640
	30	18.75	1.49	.27	.35	.87	3,585
Beef, sirloin steak.	12	15	.25	.12	.13	....	725
Butter	3	5.65	.16	....	.16	....	680
Milk, 1¾ pints.....	28	6.15	.22	.06	.08	.08	570
Potatoes...........	12	.95	.12	.01	....	.11	240
Flour	12	1.85	.65	.08	.01	.56	1,235
	67	29.60	1.40	.27	.38	.75	3,450
Beef, neck.........	10	4.40	.19	.10	.09	....	550
Butter	1	1.90	.05	....	.05	....	225
Milk, 1 pint........	16	3.50	.13	.04	.04	.05	325
Potatoes...........	16	1.25	.17	.02	....	.15	320
Oatmeal...........	4	1.25	.23	.04	.02	.17	460
Bread..............	16	4	.67	.09	.02	.56	1,280
Sugar..............	3	.95	.19	....	....	.19	345
	66	17.25	1.63	.29	.22	1.12	3,505
Beef, shoulder.....	8	6	.16	.09	.07	....	450
Salmon, canned ...	4	3.75	.10	.05	.05	....	245
Butter	2½	4.70	.13	....	.13	....	565
Milk, 1½ pints.....	24	5.25	.18	.05	.06	.07	485
Potatoes...........	8	.65	.09	.01	....	.08	160
Oatmeal...........	2	.65	.11	.02	.01	.08	230
Flour	10	1.55	.55	.07	.01	.47	1,030
Sugar	3	.95	.19	....	....	.19	345
	61½	23.50	1.51	.29	.33	.89	3,510
Beef, sirloin steak.	8	10	.17	.08	.09	....	485
Mutton chops	5	6.25	.14	.04	.10	....	465
Butter	2	3.75	.11	....	.11	....	450
Milk, 1½ pints.....	24	5.25	.18	.05	.06	.07	485
Potatoes...........	8	.65	.09	.01	....	.08	160
Oatmeal...........	3	.95	.17	.03	.01	.13	345
Bread..............	12	3	.50	.07	.01	.42	965
Sugar..............	2	.65	.12	....	....	.12	230
	64	30.50	1.48	.28	.38	.82	3,585

Daily dietaries—Food materials furnishing approximately the 0.28 pound of protein and 3,500 calories of energy, etc.—Continued.

Food materials.	Amount.	Cost.	Nutrients.				Fuel value.
			Total.	Protein.	Fats.	Carbohydrates.	
	Ounces.	*Cents.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Calories.*
Beef, round steak.	8	7	.16	.09	.07	....	425
Cod, dried.........	2	.90	.03	.08	....	....	40
1 egg..............	1½	2.00	.02	.01	.01	....	70
Butter............	3	5.65	.16	....	.16	....	680
Milk, 1¼ pints.....	20	4.40	.15	.04	.05	.06	405
Potatoes...........	8	.65	.09	.01	....	.08	160
Oatmeal	2	.65	.12	.02	.01	.09	230
Flour	10	1.55	.55	.07	.01	.47	1,030
Sugar	4	1.25	.25	....	....	.25	460
	58½	24.05	1.53	.27	.31	.95	3,500
Beef, shoulder.....	9	6.75	.18	.10	.08	....	515
Ham...............	6	6	.19	.06	.13	....	655
One egg............	1½	2	.02	.01	.01	....	70
Butter............	1½	2.80	.08	....	.08	....	340
Milk, ¼ pint	8	1.85	.06	.02	.02	.02	165
Potatoes (white)..	8	.75	.09	.01	....	.08	160
Sweet potatoes....	8	1	.12	.01	....	.11	210
Corn meal	8	1.25	.42	.05	.02	.35	825
Bread.............	4	1	.16	.02	....	.14	320
Sugar.............	2	.65	.12	....	....	.12	230
	56	23.85	1.44	.28	.34	.82	3,490
Ham	8	8	.24	.07	.17	....	870
Cod, dried.........	4	1.75	.02	.02	....	....	50
Three eggs.........	4½	6	.07	.04	.03	....	200
Butter	1½	2.80	.08	....	.08	....	340
Cheese	1	1	.04	.02	.02	....	130
Milk, 1 pint........	16	3.50	.13	.04	.04	.05	325
Potatoes (white)..	6	.50	.07	.01	....	.06	120
Sweet potatoes....	8	1	.12	.01	....	.11	210
Corn meal	8	2.50	.42	.05	.02	.35	825
Bread	4	1	.16	02	....	.14	320
Sugar.............	2	.65	.12	....	....	.12	230
	63	28.70	1.47	.28	.36	.83	3,620

Kellogg[1] has determined the nutritive values of different portions of the common articles of diet, as well as some that are not so well known, and his results are of much practical interest. By means of the tables here given one could make combinations of foods with something like precision and definiteness.

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[1] *Balanced Bills of Fare*—Good Health Pub. Co., Battle Creek, Mich.

Nutritive value of foods.

Food.	Weight Oz.	Measure.	Per Cent. of			Calories in 1 oz.
			Proteids.	Fats.	Carbohydrates.	
Bananas	2.	1 peeled	1.4	1.4	29.8	39
Oranges	2.	1 peeled	1.31	....	11.	14
Lemons	2.5	1 peeled	1.	.9	8.3	14
Berries, stewed	9.8	.5 pint	1.4	....	12.4	16
Dates	2.	7	.9	....	58.	67
Prunes, stewed	9.2	.5 pint	.5	....	14.7	17
Raisins, stewed	9.2	.5 pint	1.8	1.9	23.6	34
Apple sauce	9.5	.5 pint	.18	.24	9.4	12
Peaches, canned	9.2	.5 pint	.7	....	12.5	15
Fruit-juice	8.8	.5 pint	.7	.74	9.2	13
Sauce for grains	8.5	.5 pint	.7	.7	9.8	13
Apples, fresh	13.	2 large or 4 small	.4	....	12.	14
Grapes, fresh	5.	1 av. bunch	.6	....	16.8	19
Peaches, fresh	3.	1 peeled and pitted	.7	....	12.5	15
Apricot, canned	9.5	.5 pint	.5	....	11.	13
Grape pulp	....	....	2.	.2	21.	32
Blackberry, canned	9.2	.5 pint	.5	....	5.5	7
Cherry, canned	9.2	.5 pint	.7	....	12.	15
Pear, canned	9.2	.5 pint	.4	....	11.5	14
Strawberry, canned	9.2	.5 pint	1.1	.5	6.8	9
Whortleberry, canned	9.2	.5 pint	.8	....	5.9	8
Melon	....	....	1.	.3	2.2	5
Plum	....	....	.4	....	8.2	10
Fig	....	....	4.	....	49.8	62
Tomato	8.	1 medium	1.6	.3	2.5	12
Apple, baked	5.5	1 large	.18	.24	9.4	5
Rice, steamed	5.75	.5 pint	3.	.16	31.4	40
Oatmeal	....	.5 pint	6.4	3.9	29.7	53
Crystal wheat	7.	.5 pint	5.7	3.	29.5	49
Gluten mush	8.25	.5 pint	12.	.6	22.	44
Graham mush	7.	.5 pint	5.8	.9	35.8	52
Wheatose	7.	.5 pint	5.7	.8	29.5	44
Rice with nuttose	6.	.5 pint	4.2	1.3	32.1	46
Macaroni	6.5	.5 pint	10.	2.	75.	104
Granola	4.25	.5 pint	15.	3.	75.	114
Granose	2.75	4	15.4	2.3	79.1	117
Zwieback	2.2	2 pieces	13.6	2.	70.	104
Graham crackers	3.	6	9.8	13.6	70.	128
W. W. wafers	2.5	6	9.8	13.6	70.	128
Beaten biscuit	2.25	6	11.7	1.2	80.	110
Sticks	2.	12	11.7	1.2	80.	110
Rolls	4.	6	11.7	1.2	80.	110
Passover bread	3.75	12	11.7	1.2	80.	110
Graham bread	1.	1 piece	9.5	1.4	53.3	80
W. W. bread	1.	1 piece	9.8	1.4	50.7	75
W. bread	1.	1 piece	8.8	1.7	56.3	81
Nut-gravy toast	6.	1 piece	6.8	1.	35.	52
Prune toast	6.	1 piece	6.8	1.	35.	52
Berry toast	6.	1 piece	6.8	1.	35.	52
Cream toast	6.	1 piece	6.8	1.	35.	53
Nuttose roast	6.	.5 pint	4.3	1.9	12.5	25
Nuttose and tomato	8.75	.5 pint	4.3	1.9	12.5	25
Potato, mashed	7.75	.5 pint	3.2	.15	27.5	36
Vegetables, fresh	8.	.5 pint	1.6	.3	4.	8
Tomato, stewed	8.	.5 pint	.8	.15	1.25	3
Potato, baked	4.	1 medium	3.2	.15	27.5	36
Nut gravy	9.	.5 pint	....	....	....	....
Soup	8.5	.5 pint	.8	.2	1.	3
Sugar	7.	.5 pint	....	....	97.8	111
Beans, boiled	8.75	.5 pint	....	....	....	....

Nutritive value of foods—continued.

Food.	Weight Oz.	Measure.	Per Cent. of			Calories in 1 oz.
			Proteids.	Fats.	Carbohydrates.	
Cream	8.5	.5 pint	2.7	26.7	2.8	75
Milk	8.5	.5 pint	3.6	4.	4.7	21
Egg	1.5	1	14.	10.5	....	47
Sterilized butter	....	....	1.	85.	....	218
Kumyss	8.5	.5 pint	3.7	3.6	4.7	20
Cottage cheese	....	....	3.6	3.7	6.	20
Malted nuts	....	....	23.	20.4	49.3	140
Almond cream	....	....	2.7	26.7	2.8	75
Nut butter	8.75	.5 pint	16.4	26.4	9.5	101
Bromose	1.	2 cakes	19.6	24.	39.4	135
Maltol	9.	.5 pint	....	20.	75.	136
Nuttose	3.	....	30.	30.	13.	139
Nuttolene	3.	....	30.	30.	18.	139
Nut meal	8.75	.5 pint	28.3	46.2	1.8	161
Stewed nuttolene	9.	.5 pint	....	....	....	....
Beefsteak	....	....	19.3	3.6	.0	37

Constructing bills of fare from these tables we could make combinations like the following, which, according to Kellogg, are each equal to one-half of a ration, while Atwater and others would estimate them at one-third of a ration. Kellogg would advise only two meals a day, each affording the amount of food indicated in the combinations given; while Atwater would counsel three meals a day.

Combination bills of fare.

Foods.	Weight Oz.	Measure.	Calories or food units.	
Beefsteak	7	½ pound	Proteids	345
Oatmeal	2½	1-6 pint	Fats	175
Bread, white	6	6 slices	Carbohydr.	925
Potato	6	½ pint		
Beans	1½			
Bananas	7	3		
			Total	1,445
	30			
Eggs	3	2	Proteids	197
Bread, white	5	5 slices	Fats	526
Oatmeal	8	½ pint	Carbohydr.	590
Butter	2			
			Total	1,313
	18			
Bread, white	10	10 slices	Proteids	199
Milk	8	½ pint	Fats	458
Cream	5	½ pint	Carbohydr.	633
	23		Total	1,290
Kumyss	13	¾ pint	Proteids	296
Malted nuts	7		Fats	434
			Carbohydr.	461
	20			
			Total	1,241
Passover bread	4	13 pieces	Proteids	200
Macaroni	4	¼ pint	Fats	162
Tomato	9	1	Carbohydr.	818
Bromose	2			
			Total	1,180
	19			
Beefsteak	8	½ pound	Proteids	364
Potato	10	⅝ pint	Fats	113
Bread, white	8	8 slices	Carbohydr.	823
	26		Total	1,300
String beans	8	½ pint	Proteids	205
Tomatoes	16	2 large	Fats	409
Soup	12	¾ pint	Carbohydr.	619
Nuttose roast	7	½ pint		
Graham bread	7	7 slices		
Sterilized butter	1½			
	51½		Total	1,323

CHAPTER IV.

RELATIVE VALUE OF FOODS IN THE PRODUCTION OF NERVOUS ENERGY (cont.).

§1. *Condiments as Force Producers.*—A word should be said regarding those articles often designated as food adjuncts or food accessories, or more familiarly, condiments. These include the spices, peppers, pickles, vinegars, and all the things designed to whet the appetite, as we say. No one maintains that they possess any nutritive value, but many believe they are essential to the excitation of the digestive juices, and hence are of much worth in one's dietary. Authorities seem to agree that when food is unpalatable some of these artificial excitants may be of service; but this does not imply that the materials most nutritious and wholesome do not possess in themselves flavors which may be developed by proper cooking and which will be sufficiently stimulating to secure a generous flow of digestive juices. It deserves more than passing notice that young children cannot be induced to take food adulterated, so to speak, with these foreign substances; and it seems to be only when the digestive processes become deranged from abnormal and injurious practices that unnatural stimulants must be employed. Grant Allen[1] has pointed out that whiskey, pepper, and the like are usually found together in one's diet; organs thus overstimulated crave a continual increase in stimuli until it happens that one can enjoy no food in its natural flavors, and must add pepper, vinegar and whiskey to everything he eats in order that he may endure it at all.

On the tables in our own locality vinegar is the acid condiment most universally employed, alike in its pure state, and obscured in pickles, preserves, and similar "relishes." It is, of course, generally known that vinegar is the result of decomposition of natural fruit juices which contain the various acids, as malic, citric, etc., needed by the system to promote right digestive and eliminative processes. Vinegar, that is to say, is not found in ripened fruits before decomposition takes place. Now it is doubtless a principle of universal application in nutrition that foods are best appropriated when they are gained in their native forms, so to speak, as found in ripened fruits and grains or in animal flesh. It is to be regretted that apples and other fruits do not occupy a more prominent place in our dietary lists, when there would be less need of "pickles." The more general use of unfermented fruit juices served as sauces, for instance, is also greatly to be desired in our midst.

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[1] *Popular Science Monthly*, Vol. 26, p. 468.

§2. *The Influence of Tea, Coffee and Cocoa Upon the Production and Expenditure of Force in the Organism.*—From the point of view which is being taken in this bulletin in the discussion of nutrition, the most important food accessories are those which have a marked effect upon the central nervous system, as tea, coffee, cocoa, and the various forms of alcoholic "drinks,"—wine, beer, whiskey, and the like. It has long been held that a cup of tea or of coffee cheers but does not inebriate; and it has come to be generally felt that tea and coffee are necessary adjuncts to one's diet. Nearly every student enjoys his cup or cups of tea or coffee at every meal and many apparently believe they derive real nutrition from these beverages. The analyses[1] of tea, coffee, and cocoa which follow show, though, that while they possess a modicum of nutrients, yet one gets such a small allowance of these in the quantity of tea or coffee which can be imbibed at any meal that their nutritive value is practically zero.

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[1] Church.

Analyses of tea, coffee, and cocoa.

	In 100 parts.	In 1 pound.	
		Oz.	*Gr.*
Composition of black tea:			
Water	8.0	1	122
Albuminoids	17.5	2	350
Theine	3.2	0	234
Tannin	17.5	2	350
Chlorophyll and resin	4.5	0	315
Essential oil	0.4	0	28
Minor extractives	8.6	1	164
Cellulose, etc	34.0	5	193
Mineral matter	6.3	1	4
Composition of roasted coffee:			
Water	2.0	0	140
Albuminoids	12.5	2	0
Theine (Caffeine)	1.0	0	70
Fat or oil	12.5	2	0
Tannin	5.0	0	350
Minor extractives	14.4	2	133
Cellulose, etc	48.0	7	297
Mineral matter	4.6	0	322
Composition of cocoa:			
Water	5.0	0	350
Albuminoids	12.5	2	0
Fat	50.0	8	0
Theobromine	1.0	0	70
Cacao-red	3.0	0	210
Tannin	6.0	0	420
Gum, etc	7.0	1	32
Cellulose and insoluble matter	12.5	2	0
Mineral matter	3.0	0	210

People do not commonly prize tea and coffee, however, for their nutritive worth, but only for the stimulating effect which they exert upon the nervous system. Smith[1] has carefully studied their action upon the vital functions and it will be well to give the results of his experiments. And first regarding tea:

"*1. As to the Carbonic Acid Evolved in Respiration.*

"1. One hundred grains of the finest black tea gave a maximum increase of 0.87 grain and 1.72 grain per minute in 50 and 71 minutes on two persons.

"2. Fifty grains gave to four persons maxima of increase of 1.08, 1.38, 2.58, 1.6, 2.0, and 0.69 grains per minute, under different experiments.

"3. One hundred grains of the finest green tea, drank when cold, gave maxima of increase of 0.9, 2.58, and 0.64 grains per minute on three persons.

"4. Twenty-five grains of green tea, drank when cold, and after having been infused several hours, and repeated every quarter of an hour, for five doses, gave an average increase of 1.2 and a maximum increase of 1.8 grain per minute. The total increase, as shown by ten observations, was no less than 193 grains; and at the close of the experiment the increase continued at the rate of 54 grains per hour.

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[1] Op. cit., pp. 347–350.

"5. When 150 grains of black tea, infused in one pint of water, were taken, and the whole carbonic acid was collected for 65 minutes, it was shown that there had been an excess of 51.36 grains evolved, which was not more than one-fourth of the total increase when the tea had been divided into repeated doses.

"6. When we took 100 grains of black tea, and the whole carbonic acid was collected during 1 hour and 50 minutes, the total increase was 70.40 grains.

"2. *As to the Volume of Air Inspired.*

"There was an average increase in the quantity of air inspired in every experiment but one. Thus pursuing the order of the above mentioned experiments,

In No. 1, the quantity was increased by 71 and 68 cubic inches per minute.
In No. 2, the increase was 34, 39, 50, 72, 95, and 26 cubic inches per minute.
In No. 3, the average increase was 120 and 50 cubic inches.
In No. 4, the average increase was 66 cubic inches.
In No. 5, the maximum increase was 92 cubic inches.
In No. 6, the average increase was 47.5 cubic inches.

"3. *As to the Depth of Inspiration.*

"The rate of respiration either did not increase or was lessened; and as the volume of air inspired was increased, the depth of inspiration was greater so that the increased volume of air inspired at each inspiration varied from 3 to 10.6 cubic inches. With this increased depth, there was also a sense of greater freedom of respiration.

"4. *As to the Rate of Pulsation.*

"The rate of pulsation followed that of respiration, but in a less degree, and was either not increased or was slightly decreased.

"Hence it was proved beyond all doubt that tea is a most powerful respiratory excitant. As it causes an evolution of carbon greatly beyond that which it supplies, it follows that it must powerfully promote those vital changes in food which ultimately produce the carbonic acid to be evolved. Instead, therefore, of supplying nutritive matter, it causes the assimilation and transformation of other foods

. . . .

"Hence, in reference to nutrition, we may say that tea increases waste, since it promotes the transformation of food without supplying nutriment, and increases the loss of heat without supplying fuel, and it is therefore especially adapted to the wants of those who usually eat too much, and after a full meal, when the process of assimilation should be quickened, but is less adapted to the poor and ill-fed, and during fasting."

His experiments with coffee show an influence similar in a way to that of tea. He says:[1]

"Of twenty-three experiments on myself and others there was from half an ounce of coffee an increase in the quantity of carbonic acid evolved of 0.98, 1.02, 0.9, 0.4, 1.16 and 2.54 grains per minute at different times, whilst the quantity of air inspired was increased 40, 34, 35, and 84 cubic inches per minute with the same experiments. Three-quarters of an ounce of coffee did not give a greater increase, but the actual increase was 0.68 and 1.68 grain of carbonic acid and 28 and 54 cubic inches of air per minute.

"The conditions, therefore, under which coffee may be taken are very different from those suited to tea. It is more fitted than tea for the poor and feeble. It is also more fitted for breakfast, inasmuch as the skin is then active and the heart's action feeble; whilst in good health and with sufficient food it is not needful after dinner, but if then drank should be taken soon after the meal. Hence in certain respects tea and coffee are antidotes of each other, and we know that they are now taken indiscrimihately, although in a chief action they are interchangeable.

"Coffee is an excitant of the nervous system, but not in the same degree as tea. It produces sleeplessness in many persons when it is taken at night, probably by exciting the heart's action, and preventing that fall which is natural at night, and requisite to permit sound sleep. I do not think that there is the same degree of reaction after taking strong coffee as follows strong tea. It is needless to add, that none of these effects may be marked if the infusion be very weak, as is common among the poor, and in this respect it resembles very weak tea."

I am not familiar with the results of experiments relating to the influence of cocoa; but it is known that its active principle, theobromine, resembles the active principles of tea and coffee, theine and caffeine, and it is probable that its action in the system is somewhat like these.

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[1] Op. cit., pp. 365–367.

It must be apparent, then, that these beverages containing alkaloids really operate in dissipating rather than in conserving energy. They are doubtless of assistance to an organism that needs to get rid of superfluous materials. One who does not require all the energy of his food for mental or physical labor may to advantage call tea and coffee to his aid to relieve his system of a burden. But this is a situation which does not commonly exist in student life. Students, as a body, are not likely to consume more food than is required for the best efficiency of mind and body even when the total amount of energy it yields is expanded in profitable production. And then the average college man or woman is illy prepared, from the financial point of view, to provide for the waste of food which the habitual use of tea and coffee entails. It is recognized, of course, that conditions may exist when tea, coffee, and similar things have a therapeutic value; but we are concerned here not with the needs of the organism in disease but only in full health and vigor.

The exhilaration which follows a cup of tea or coffee is significant for the psychologist as well as for the student in the practical affairs of daily life. This is possibly due to a paralyzing effect for the moment upon the inhibitory or controlling mechanisms in the central nervous system which report the true condition of the organism, and seek to prevent it from passing the safety line in its activities. To illustrate the theory by fatigue: The fatigue sense, as has been said, exerts an inhibiting influence upon activity; the rate and strength of movements show decrease; mind and body become relaxed, and under normal conditions the individual tends to fall asleep in order that there may be repair of waste. When this sense reports the status of the body in fatigue there is a feeling of depression, of lassitude; but if its restraining power can be overcome in any way there will apparently be a return of wonted vigor. But what the welfare of the system requires at this time is rest and food to restore dissipated energy, not incitement to still greater dissipation; and while in certain situations it may be advisable to stimulate by weakening the controlling and warning functions of the body, yet to make this a systematic, daily practice is to render the organism in the end less efficient mentally and physically. It is not an over-statement to say that a student living a normal life with all his powers under control, which requires, speaking neurologically, that his nervous system should be in a state of thorough nutritive repair,—such a student will not be benefited but rather be injured by the stimulations derived from habitual indulgence in tea and coffee.

Before taking leave of this subject I must quote the testimony of Williams[1] regarding his personal experience with tea:

> "I recommend tea drinkers who desire to practically investigate the subject for themselves to repeat the experiment that I have made. After establishing the habit of taking tea at a particular hour, suddenly relinquish it altogether. The result will be more or less unpleasant, in some cases seriously so. My symptoms were a dull headache and intellectual sluggishness during the remainder of the day—and if compelled to do any brain-work, such as lecturing or writing, I did it badly. This, as I have already said, is the diseased condition induced by the habit. These symptoms vary with the amount of the customary indulgence and the temperament of the individual. A rough, lumbering, insensible navvy may drink a quart or two of tea, or a few gallons of beer, or several quarterns of gin, with but small results of any kind. (I know an omnibus driver who makes seven double journeys daily, and his 'reglars' are half a quartern of gin at each terminus—i. e., 1¾ pints daily, exclusive of extras.) This would render most men helplessly drunk, but he is never drunk, and drives well and safely.
>
> "Assuming, then, that the experimenter has taken sufficient daily tea to have a sensible effect, he will suffer on leaving it off. Let him persevere in the discontinuance, in spite of brain languor and dull headache. He will find that day by day the languor will diminish, and in the course of time (about a fortnight or three weeks in my case) he will be weaned. He will retain from morning to night the full, free, and steady use of all his faculties; he will get through his day's work without any fluctuation of working ability (provided, of course, no other stimulant is used). Instead of his best faculties being dependent on a drug for their awakening, he will be in the condition of true manhood,—i. e., able to do his best in any direc-

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[1] *Chemistry of Cooking*, p. 257.

tion of effort, simply in reply to moral demand; able to do whatever is right and advantageous, because his reason shows that it is so. The sense of duty is to such a free man the only stimulus demanded for calling forth his uttermost energies."

To obviate the evils attendant upon the continual use of tea and coffee Count Rumford made a suggestion many decades ago which is being practically embodied today in the manufacture of a substitute therefor. He gave these directions for the preparation of the substitute:[1] Take eight parts by weight of meal and one part of butter. Melt the butter in a clean iron frying pan; and when thus melted, sprinkle the meal into it. Stir the whole briskly with a broad wooden spoon or spatula until the butter has disappeared and the meal is of a uniform brown color like roasted coffee, great care being taken to prevent burning on the bottom of the pan. A small portion of this composition was then to be placed in boiling water and an infusion obtained in the same way as in the case of tea or kindred beverages. This would answer one purpose, if none other, for which many people imbibe tea and coffee, that they may have a warm drink while partaking of solid food. Rumford's substitute has been much improved upon in our own day in the manufacture of cereal coffees which are in some instances at any rate alike palatable and nutritious. It would certainly be of advantage to a student in the economy of his energies and his purse if he should reduce the quantity of his tea and coffee, replacing it in whole, or at least in part, by Count Rumford's substitute, or some other modern version of the same. It perhaps should be said that one who has acquired great fondness for the stouter drinks will not at the beginning find the substitute quite so agreeable to the palate because not so stimulating; but I have been able to observe a trial made in a boarding house in our own city where in several cases the use of the substitute for a few days served to make it thoroughly acceptable, and even replaced the older beverages in the novices' favor.

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[1] Williams, op. cit., p. 245.

§3. *The Influence of Alcohol in Wine, Beer, and Other Beverages in the Production and Expenditure of Force.*—We come now to discuss a group of articles demanding particular consideration,—those containing alcohol in combination with various other ingredients, as found in beer, wine, whiskey, and the like. It was not thought necessary nor perhaps desirable to try to find out in our questionnaire how extensively these are used by our own students; but it is well known, of course, that to some extent here, as elsewhere, alcoholic beverages are indulged in. The composition of beer and wine, the beverages most commonly drunk, reveals at the outset the fact that they cannot be regarded as foods in the proper sense. The following is the list of the chief compounds known to occur in beer:[1]

1. Alcohol, or spirits of wine, from 8 to 3 per cent.
2. Dextrin, about 4.5 per cent.
3. Albuminoids, about 0.5 per cent.
4. Sugar, about 0.5 per cent.
5. Acetic, Lactic, and Succinic Acids, about 0.3 per cent.
6. Glycerin, about .22 per cent.
7. Carbonic Acid Gas, about 0.22 per cent.
8. Mineral matter, about 0.3 per cent.

The following table shows the quantities of alcohol and other elements contained in fair average samples of one imperial pint each of eight different kinds of wines commonly consumed in our region:[2]

Name of wine.	Alcohol (absolute).		Tartaric and other fixed acids.	Acetic acid.	Sugar.		Ethers.	Mineral matter.
	Oz.	*Gr.*	*Gr.*	*Gr.*	*Oz.*	*Gr.*	*Gr.*	*Gr.*
Hock	1	219	39	18	None.		4	16
Claret	1	306	31	18	None.		6	18
Champagne	1	343	20	10	1	120	5	20
Burgundy	2	15	24	17		10	6	18
Carlowits	2	35	36	19	None.		5	16
Sherry	3	147	24	12	0	236	4	38
Madeira	3	218	26	18	0	175	5	33
Port	3	218	23	12	0	359	6	20

The principal constituent, aside from water, of whiskey, rum, and brandy, like wine, is alcohol, which indeed is the principle of primary importance in all alcoholic beverages. The whole class, therefore, and especially in view of the subject we have under consideration, is to be considered in respect of its effect upon the central nervous system and not in regard to its nutritive value.[1] It has been observed by people from aforetime that alcohol in its first effects usually, though not always, increases the activity of mind and body: the senses apparently become more acute, checks upon speech are released, and bodily movement is augmented. This phenomenon has been ascribed to the exciting influence of alcohol upon brain cells; it has been thought to act directly upon the perceptional, ideational, and motor regions, inciting them by a kind of irritation or inspiration, to heightened and intensified action. But we get a different conception of the case if we look at it from the point of view of modern neurology. At the risk of wearying the reader, I repeat that an important part of the nervous mechanism is concerned with co-ordinating the activities of mind and body. Higher and more differentiated centers control and correlate lower and more fundamental ones. Now it seems that the influence of alcohol in the organism may be explained most satisfactorily by supposing that it has a general paralyzing effect upon nerve structures, first attacking the inhibitory system and nullifying its restraining power. This produces temporary exaltation when one is depressed and a general increase in activity due to the rebound of the system from the constriction that had been placed upon it. But it is well known that as the influence of alcohol increases in the organism the higher mental processes and the more delicate motor co-ordinations are soon attacked; and ultimately even the most fundamental functions are paralyzed when both mind and body fall into a wholly disorganized condition. Intoxication means, considered from one point of view, the temporary destruction of psychical and physical functions which it has taken nature an infinitely long time in the process of evolution to elaborate. One would certainly not be extreme in saying that an intoxicated person returns to the estate of the brute, since while he is in this condition the higher cerebral structures, those which have been built in the last stages of the evolutionary process, through which are manifested the highest attributes of the human mind, are rendered inactive, and the individual lives for the time being upon a lower plane, when old reflex arcs again become complete and have their way. If from the point of view of science there are such creatures as fools, then a man, and especially a student, who will deliberately become drunk, must certainly be catalogued in this group. Let it be remarked in passing that no more pitiable or grievous spectacle can be witnessed than that which is presented when a number of university men, in whom should be evidenced the glory and triumph of evolution, and who above all others should be the last to yield mental poise and balance, its supremest blessing,—when such men forfeit the right to manhood and voluntarily bring upon themselves dissolution, intellectual, emotional, and physical.

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[1] Church, op. cit., p. 190.

[2] Idem., p. 194.

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[1] Since the above was written I have read Prof. Atwater's Report to the Middletown Scientific Association in which he takes the view that alcohol is a food; but he would, I believe, agree to the statement I have made that its effect upon the nervous system is after all the vital matter for every one of us.

The view which is here presented of the neurological influence of alcohol as a paralyzing agent upon nerve action and control is not a wholly new one. I find that the eminent physician Harley arrived at this opinion some years ago, approaching thereunto by a different route from that taken above. He says:[1]

> "Alcohol, when taken in small quantity, is in general said to act as a direct cardiac stimulant, and its stimulating effect is supposed to be due to its possessing the faculty of increasing the muscular power of the heart. I take an entirely different view of the matter, and shall now endeavor to show how the increase in the force of the heart's movements, the quickening of the pulse, the flushing of the face, the congestion of the retinal blood-vessels, as well as all the other visible appearances of accelerated cardiac functional activity, are in reality in no wise due to the stimulating action of alcohol, either on the heart's muscular tissue or the nerves supplying it, but actually to the very reverse—namely, its paralyzing effects

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[1] Popular Science Monthly, Vol. 33, pp. 191–199.

on the cardiac nerve mechanism. Destroy or paralyze the inhibitory nerve-center, or arrest its power of communicating with the heart by dividing the vagus, and instantly its controlling effect on the cardio-motor mechanism is lost, and the accelerating agent, being no longer under its normal restraint, runs riot. The heart's action is increased, the pulse is quickened, an excess of blood is forced into the vessels, and from their becoming engorged and dilated the face gets flushed and the retina congested—all the usual concomitants of a general engorgement of the circulation being the result.

"The relative effects of alcohol and opium were found to be as follows:

In 100 parts of air.	Oxygen.	Carbonic acid.	Nitrogen.	Vol. at O. C. at 1 metre pressure.
Composition of employed air..............	20.9	0.002	79.038	30.96
With pure ox-blood.........................	10.58	3.330	86.09	14.91
With pure ox-blood 5 per cent. of alcohol	16.59	2.380	81.03	18.97
With pure calf's blood	6.64	3.47	89.89	10.11
With pure calf's blood .005 grm. of morphia	17.17	1.00	81.83	18.17

Dr. Gaulé,[1] of the University of Zürich, has advanced a somewhat similar opinion of the influence of alcohol in considering its relation to happiness; and his views are eminently suggestive to the student who fancies that an efficient way to meet difficulties is to forget them or imagine them out of existence or of less consequence and importance than they really are, by maiming those powers of the mind that give an accurate description of situations as they actually exist.

"* * * So the influence of alcohol is exactly as if the brain were cut away. The man no longer stops to consider the whole situation, to make use of impressions of former experiences stored away in the brain, or weigh present obligations. How does it increase the feeling of happiness? The body uses its powers in resisting the outside forces which act upon it. Normally, there is a balance between body and environment. If environment prevails we are discouraged; and if we are able to prevail, our spirits rise and our happiness grows. And it is not for the moment only, but we compare the accumulated impressions of the powers outside of us with the powers which our brains develop, and are happy or unhappy according as we feel our superiority or otherwise. Just how much does alcohol interfere in this balance of powers? It clearly cannot lessen the power of outside influences which harm us; it can as clearly not increase our own powers in so far as they enter into this conflict with the outside world—it rather makes us less skillful and able. What can it do, then? It can deceive us. It dulls our appreciation of powers outside of us until they seem so much smaller that we are sure we can conquer them, and so we gain a feeling of satisfaction."

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[1] Popular Science Monthly, Vol. 46, pp. 30–31.

Wilson[1] has shown most conclusively that the drunkard is simply a person in whom has become permanent the inco-ordinations, the lack of control which is always induced temporarily by any single spree. The balance-wheel is thrown out of gear for good. The man is a creature of impulse, and that unfortunately of a low type; the regulating, the subduing, really the spiritual mechanisms of his being, have been paralyzed so often that they are at last rendered permanently inactive. This extreme case is cited simply to throw into clearer light the ordinary effects of alcohol, which, although when taken in small quantities may never produce great damage to the organism, yet there must always be grave danger in its use. Maudsley, after lifelong study of the causes of mental derangement, has much to say[2] of the baneful influence of this agent; and Mercier, a student of insanity too, is unsparing in his condemnation of alcohol, and a few of his words[3] may be quoted in support of the views presented in these paragraphs,—that alcohol is a factitious force-producer, and when used habitually results eventually in the dissipation of energy, and sooner or later disturbs the delicate mechanisms by which the organism is held under the control of a vigorous will.

"Ask a man who has just left a city dinner to settle with you the lease of a house, or a deed of partnership. He will naturally refuse. If you press him, he will say that it is not a proper time to transact business; and, if pressed further, will explain that to take him now is unfair, for to such an important and delicate matter one must come with a clear head. The admission is that the mind is not now as vigorous as it will be tomorrow morning. There is a slight enfeeblement. Partly from the fatigue of the day, partly from the effect of the dinner in drafting off a part of the blood supply from the brain to the stomach, but chiefly from the benumbing effect of the alcohol that he has imbibed on his highest nerve regions, his mind is not as clear nor as vigorous as it is wont to be. The confusion is not great; he can make an after-dinner speech of average intelligence, can reckon his legal cab fare, and so forth, but he will not trust himself to settle a delicate matter of negotiation. He feels that the keen edge of his intellect is blunted. It is the very highest of all his intellectual faculties that have been dulled. Similarly on the bodily side—he can walk perfectly straight, can light a cigar without bungling, and button his overcoat with facility; but when he tries to play billiards he finds 'his hand is out.' He is not certain of his strokes. He can no longer regulate his movements with the nice precision that is required for success. Of bodily, as of mental capabilities, he has lost the most elaborate, the most delicate, the most precise. At the same time that he shows these signs of defect in his highest nerve arrangements, he shows some sign of over-action of somewhat lower arrangements. By the annulling and placing out of action of the highest, control is removed from those just below the highest, which are consequently 'let go' and tend to over-act. The staid and self-enclosed man of business becomes an expansive, jolly companion. He gets on back-slapping, rib-punching terms with his convives. He tells little anecdotes about his past career, with winks, and wheezes, and warnings that they are not to be repeated to his wife. His discretion and reticence are diminished by the loss of his highest centers and he exhibits a phase of character inferior to his usual standard. No one would call this state of things insanity; but for all that it is the beginning of a process which, if continued, would become insanity. It is the point at which divergence from the processes of health begins to occur. It is not insanity, but it is the rudiment of insanity. Let us trace the process further and see what it develops into."

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[1] *Drunkenness*, Part I. See also Richardson, *Ten Lectures on Alcohol*, pp. 128–179.

[2] See *Responsibility in Mental Disease*, pp. 285–286.

[3] *Sanity and Insanity*, p. 316.

When one looks at this subject from the standpoint of education he sees that the university student less than any one else should need to quicken and intensify the psychic life by the employment of an artificial excitant. While it is the testimony of those who should know that the initial effects of wine are stimulating to thought and feeling, and there is a general buoyancy and perhaps elevation in the entire being, yet this advantage can be secured in other ways more normal and therefore more beneficial to the finest quality of mind. That mental exaltation which results from the enjoyment of beautiful art and music and intercourse with inspiring people can readily beget that fine ecstacy which has made wine so celebrated in song and story. There is surely more of lasting joy in becoming drunk with grace and beauty than with wine; beauty exerts an integrating influence, it adds to the vitalities of life; while wine disintegrates and dissipates energies. Considering that the university student has special obligations to the commonwealth by whose bounty he is receiving the blessings of education, then he above all others should secure his mental gladnesses and gayeties through means which will confer upon him increasing power and balance rather than through those alluring agents which may momentarily give pleasure but which in the end are destructive rather than constructive.

The value of any food must be determined in a final analysis by its force-producing capabilities. If beer, wine, and whiskey impart energy to the organism this should be revealed in increased activity of mind and body. Research has shown in some measure at any rate that instead of alcohol thus augmenting the amount of work which an individual can do, it actually reduces it. Martin[1] observes that the evidence adduced by competent observers is distinctly against the use of spirits by soldiers in time of war. He says there is no cogent evidence to show that alcohol is of service in sustaining bodily activity. Hodge's investigations are of especial significance on this point. Professor Hodge was enabled a few years ago to conduct a series of experiments under the auspices of the Committee of Fifty for the study of the liquor problem, wherein he carefully observed the mental and physical effects upon a number of dogs of alcohol administered in the forms of beer, wine, and whiskey. The results so far as they refer to the particular topic under discussion—the value of alcohol as a force producer in a living organism—may be presented in his own words:[2]

"During the second month after administration of alcohol spontaneous activity of both Tipsy and Bum became noticeably impaired.

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[1] *Treatise on Hygiene*, Stevenson & Murphy, Vol. I, p. 487.

[2] Popular Science Monthly, March and April, 1897, and reprint.

This gradually and steadily increased until, last spring, it seemed to me from daily observation that the alcoholics were not much more than half as active as the normals. How to secure an objective expression of this fact presented some difficulties at first. To put them in large recording cages, such as we use in the laboratory to study the daily activity of rats and mice, would clearly be an imposition on a dog's good nature, and would possibly suppress his activity in proportion to his intelligence. To watch four dogs during the twenty-four hours would require four observers, and their presence would be a disturbing factor.

"Pedometers were thought of, but none could be found suitably constructed for use with the dogs. Finally, Waterbury watches were obtained, and, by removing the hair springs, weighting the balance wheels unequally, and by proper adjustment of buffing pins so that the balance wheel could move just far enough to release the escapement, a watch resulted which ran only when shaken. After a month of preliminary trials an adjustment was attained so delicate that the watch could hardly be jarred so slightly as not to release the escapement one tooth, and the two could be shaken, violently or gently, and in any position for an hour at a time (fastened firmly together) without showing a variation of more than two seconds on reading the hands.

"The watches are now placed in stout leather pockets in specially constructed collars and the dogs allowed to wear them. * * * The watches were read every evening at exactly six o'clock. Bum is seen to develop seventy-one per cent. of Nig's activity, and Tipsy only fifty-seven per cent. of Topsy's.

"The watches, of course give us only the total quantity of spontaneous daily movement of each dog with no indication as to its quality. Something to give a qualitative expression of strength, ability, and resistance to fatigue was devised, which consisted in a series of competitive tests at retrieving a ball. The balls were thrown in rapid succession across the university gymnasium, one hundred feet, and a record was kept of the dogs that started for it and of the one that succeeded in bringing it back. One hundred balls constituted a test, and to throw them consumed about fifty minutes.

"In the first series, consisting of 1,400 balls thrown on successive days, January, 1896, the normal dogs retrieved 922, the alcoholics 478. This gives the alcoholics an efficiency of only 51.9 per cent. as compared with the normals. Bum's ability in this series as compared with Nig's is only thirty-two per cent. (See Fig. 18.) It was also noted that Bum and Tipsy were much more easily fatigued than the normals.

> "A second series, of 1,000 balls, November, 1896, in which Bum and Nig, were tested, gave similar results. Nig shows fifteen per cent. of Bum's fatigue. Expressed in other words, Bum lies down to rest 6.7 times to Nig's once."

In discussing the results of these experiments, Dr. Hodge quotes Professor Gaulé to the effect that once during the strain of his *Staatsexamen* he suddenly stopped his wine and beer and was surprised to find how much better he could work. An eminent Leipsic professor has said that German students could do twice the amount of work if they would let their beer alone. Dr. August Smith found that moderate doses of alcohol not sufficient to intoxicate lowered psychic ability to memorize as much as seventy per cent.[1]

From whatever position, then, we regard the influence of alcohol upon the force-generating power of the organism, we find on every occasion that it has only a deleterious issue, except of course when it is employed as a therapeutic agent.[2] The practice in which students ofttimes indulge of exciting good cheer by a few glasses of beer or wine must certainly in the long run lessen the efficiency of mind and body. When a great feat is to be undertaken, as upon the football field, alcoholic beverages are absolutely prohibited the contestant. A student should regard his daily tasks as all being great ones for which he must prepare himself most effectively mentally and physically. The ordeals of the student in his immediate classroom duties and in the more important businesses of post-university life should demand as clear and vigorous a brain and as agile and serviceable a body as the athlete requires to meet the difficulties which he will encounter in the arena.

§4. *The Influence of Tobacco Upon the Production and Expenditure of Force in the Organism.*—While alcohol operates to throw off the brakes which nature places upon the organism when danger is sighted ahead, tobacco seems to have a directly contrary influence. It is the common testimony of smokers that after a day of severe labor or intense excitement or exertion of any kind, when the mind is chaotic, uncontrolled, and repose is impossible,—in such an event, the cigar or the pipe has a soothing, calming effect. Nicotine seems to act as a stimulant to the inhibiting centers of the nervous mechanism. In view of this well known action of tobacco, it can be seen why in cases of fatigue when the mind cannot be held in check and energy is being wasted despite efforts at conservation,—in such a situation tobacco must be regarded as a conserver of force. It aids the organism to get hold of itself, to become controlled. This is especially true when, as smokers so frequently testify, tobacco skillfully wooes Morpheus when nothing else will entice him to one's bedside.

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[1] Hodge, op. cit., p. 25.

[2] Atwater's investigations already referred to seem to present alcohol in a more favorable light. Small quantities of alcohol are not injurious, says Atwater, but yet there are grave dangers in its use, since it is difficult for the habitual drinker to avoid excesses.

But this does not of necessity imply that tobacco is a valuable auxiliary to the student's dietary. It is not too much to suppose that under normal and healthful conditions a student will rarely reach the point where he will need any other sedative agent than that furnished by an abundance of nutritious food, vigorous exercise, and refreshing sleep. As a matter of fact, though, our young men taken as a whole do not smoke because they feel the need of the soothing influence which it affords; they smoke because custom dictates it. This is evidenced by the irrational way in which they do it; and it is suggestive, too, that practically all of the law students who replied to our questionnaire smoke, while about 55 per cent. of the "Hill" students are "abstainers." To smoke immediately after breakfast is as foolish as it is useless; for at such a time tobacco rather hinders than helps the organism to accomplish the tasks before it; except possibly in those instances when the system has become so permeated with nicotine that it is, in common with the well-known effects of opium, creating an abnormal desire which is unrelenting every hour and minute of waking life. As Richardson well says in his Diseases of Modern Life:[1] When mental labor is about to be undertaken a pipe produces in the majority of people a heavy, dull condition, which impedes digestion and assimilation, and interferes in some degree with that "motion of the tissues which constitutes vital activity." But when the mind is occupied for a long time, so that exhaustion supervenes, a pipe gives to some *habitues* a feeling of relief; it soothes, it is said, and makes possible clear thinking. Few men become so habituated to the pipe that they can begin the day well on tobacco. "Many try, but it almost invariably obtains that they go through their labors with much less alacrity than other men who are not so addicted."

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[1] P. 316.

CHAPTER V.

THE PREPARATION OF FOOD—HOURS FOR MEALS.

§1. *The Philosophy of Cookery.*—While the composition of a food is an important factor in determining its worth, yet a more important factor still, perhaps, is the manner in which it is prepared for use in the organism,—the manner in which it is cooked, that is to say. This is seen to be true when it is realized that man is a cooking animal, and as such is distinguished from the rest of creation. It seems to be clearly revealed in his constitution that he was not designed to take into his stomach in the raw condition in which they are found in nature most of the articles which constitute his dietary. He is not a graminiverous animal; he lacks the long alimentary tract, the special stomach, and the apparatus for secreting large quantities of saliva which is possessed by the cow and other grain munchers. The crops of birds probably fulfill somewhat the same function in the digestive processes that the second stomach does in the ruminants; and in both cases this elaborate apparatus is necessary in order to transform starch and other food elements into assimilable products. Again, man does not appear to be adapted to eat meat unsubdued by heat; sentiment if nothing more would forbid his doing this. The human species has progressed to the point in the evolutionary scale where it can call to its aid forces which are capable of advancing foods as they are found in their native state far along in the process of digestion, so that when taken into the system they may be assimilated with comparatively little delay or expenditure of vital energy.

It may be observed in passing that in all likelihood this accomplishment more than any other has contributed to the rapid mental progress and present superiority of mankind. Spencer[1] has pointed out that animals which live upon coarse, indigestible foods, as the cow and the sheep, are, considered in respect alike of physical power and mental acuteness and vivacity, relatively inferior in the scale of being. Now, it seems a safe inference from the evidence everywhere at hand that the quota of energy which can be expended in mental and physical activity will be determined by the ease with which this may be obtained in the process of nutrition. It is a fact of daily experience, probably as common in student life as elsewhere, that when the stomach is overloaded with indigestible and waste materials the mind is inert and confused, and the body little disposed to vigorous or lively activity. Let any one recall his mental and bodily status after assisting at the ordinary Thanksgiving feast, or perhaps even the familiar Sunday dinner. Sabbath afternoon is so frequently a time for loafing in both body and mind, not because one wants to rest but because he cannot arouse himself. Many of our students have a still more impressive experience; not infrequently they are required to rush off precipitately to their university duties directly following upon a meal which taxes the organism to the utmost,—oatmeal cooked a half hour or less, fried potatoes, fried meat or eggs, hot bread and cakes, and coffee,—a combination which, as will be shown later, is more than a match for the most energetic and powerful digestive mechanism. At such a time the mind works slowly and inaccurately; and the philosophy of the thing is not at all abstruse. When food is taken into the system the organism will if necessary turn its energy wholly to extracting the nutrition contained therein. Suppose then that a considerable amount of half digested starch and other food materials find their way to the stomach; there is needed at once force to transform these into assimilable substances. The blood, rushing to the appropriate organs to supply the required digestive agents, must, of course, be withdrawn from the service of the cerebral and muscular systems. When, on the contrary, food is eaten which is nearly ready for assimilation, the organism can while attending to the now easy labor of digestion engage also in a measure in mental or physical work.

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[1] *Education*, chapter on Physical Education.

§2. *Modes of Cooking. Local Practices with Criticisms.*—As has been said, the primary purpose of cooking is to advance the assimilability of foods as they are found in the raw state so as to relieve the digestive apparatus of much arduous drudgery. For the most part this is accomplished by applications in one form or another of heat. In the cookery of meats it should be the aim to soften tissues and develop flavors which will excite digestive juices; and those modes will be most efficient which will attain these ends while not destroying the nutritive properties. In roasting, baking, and broiling heat is applied directly to the surface of the meat; whereas in boiling and frying it is conveyed by convection, in the first instance through water, in the second through oil. Now, one of the most valuable elements of meat, albumen, exists in considerable quantities as a juice; and this escapes with comparative ease in boiling when the meat is put into cold water and gradually raised to the boiling temperature. When the meat is thrust into boiling water at the outset, however, the pores in the surface become closed in such a way as to prevent in a large degree the loss of the juices, and the cooking may proceed with comparatively little waste. The most economical modes of cooking this article, though, are those in which a high degree of heat is applied directly, as in baking, broiling, or roasting. Frying is the most objectionable method of all, and especially the sort of frying which one finds in the average boarding-house or even in the majority of homes. Here the cook places a little oil in the bottom of the frying pan "to keep the meat from sticking to it," and heats it to a point at which the fat is partly decomposed; she never imagines that in frying cooking should be accomplished in the same way as in water except that a different medium is used. What is to be secured is the transmission of heat through the oil. Cooking in this way would not be so objectionable if a *bath* of fat were used instead of a little in the bottom of the frying pan; although even here food is liable to be made indigestible by becoming fat soaked, so to speak. It is of course well-known that the fat which incases the nutritive elements in fried meats, eggs, and the like digests lower down in the digestive tract than the substances themselves, so that these latter are held in the stomach for a long period, resulting usually in fermentation, and greatly overtaxing the stomach.

An examination of the returns from our questionnaire shows that meats, potatoes, eggs, and cakes are as often fried as cooked in any other way; and this cannot but be regarded as a very serious defect in local practice. And I know from personal experience that the frying which is done in some places here renders the food highly indigestible. A breakfast of fried pork, fried eggs, fried potatoes, fried pancakes, and doughnuts must very successfully prevent for several hours vigorous activity in the head of almost any student. There is no danger in saying emphatically that food prepared in this way is unfit for the needs of a student or, in fact, of any civilized being; and it may not be out of place to observe that the state is bestowing its favors in an unprofitable manner in attempting to educate an individual who habitually regales himself on fried stuffs, and especially such a variety as the landlords in our locality provide for their guests.

But the cooking of meats, bad as this is even, is not so defective in Madison boarding houses, as the cooking of starch foods,—the cereals, bread, vegetables, cake, and the like. It has previously been indicated that starch in order to be incorporated into the system must become converted into dextrin. This is accomplished in the ordinary process of digestion by insalivation, wherein the active digestive principle of saliva is brought into contact with the starch granules of food. Starch may, however, be digested in other ways. It is well known, for instance, that the nitrogenous principle, diastase, obtained in malting, possesses the power to carry starch along through several of the stages essential to complete conversion into dextrin. It is also known that digestive changes may be wrought by the application of dry heat to starch. If you place starch granules in an oven heated to the temperature of 300°, they are not apparently affected at all; but if you increase the temperature 100° or thereabouts they will suddenly be transformed into dextrin. The change is an isomeric one, for dextrin is of the same composition as starch.

Now, the primary purpose in cooking the starch foods placed on our tables should be to convert the starch so far as possible into dextrin. Starch, as it is obtained in grain foods, cannot be converted into dextrin without subjecting it for a long time to heat, either directly or through convection in cooking in water. The boiling of raw oatmeal for say thirty minutes will not in all probability suffice to carry the starch far along in the process of digestion, and this work must be completed after the food is taken into the stomach if much nutritive value is to be derived from it. On the other hand, if the cooking had been carried on for a longer period less would have been left for the stomach to do, which is the great object to be attained in the cooking of these foods,—the relief of the digestive apparatus. The processes essential to complete starch digestion have been excellently set forth in a pamphlet presenting the results of experiments prosecuted in the food laboratories of the Battle Creek Sanitarium, in which it is shown that "water-brash" and other dyspeptic symptoms so common among the Scotch Highlanders is due to the excessive use of "Scotch brose," which is simply raw oatmeal stirred up in hot water. The prevalence of indigestion in our own country, too, is due principally to the same cause,—the use of starchy or cereal foods in an uncooked or imperfectly cooked condition. The pamphlet goes on to say that:

"The bread of the olden time consisted of thin cakes formed from a mixture of flour and water, well kneaded and baked on a tin or stove kept hot by a glowing fire. Bread prepared in this manner is ready for prompt digestion and assimilation.

"The transformation of starch into sugar—in other words, the digestion of starch—takes place by stages. The starch is first converted into

"(a) Amylo-dextrine, or soluble starch. This is the form in which it is found in well-boiled paste and in ordinary baker's bread, in so-called ready-cooked breakfast cereals, and in mushes, gruels, vegetable soups, and similar preparations of starch.

"The third stage is that of (c) achröo-dextrine, that in which the starch is found in such perfectly cooked cereal foods as zwieback, granose, and granola, and in the outer browned portion of the crust of bread.

"In the second stage (b) the starch is further transformed into erythro-dextrine, the form in which it is found in what might be termed the half-cooked condition of well-baked ordinary baker's bread, in crackers, rolls, gems, and similar foods.

"The fourth stage is maltose or sugar, the final results of starch digestion. The digestion of starch is accomplished in nature by the action of so-called ferments or diastases. These are found abundantly in both the animal and vegetable kingdoms,—in animals in the saliva and other digestive fluids. In grains, the starch digesting ferment or diastasis is found just beneath the bran, ready to form sugar for the nourishment of the young plant. The starch found in green apples and other fruits is, by the process of ripening, converted first into the various ferments or dextrines exclusively, and finally into sugar.

"The formation of the last form of dextrine is indicated by the appearance of a slight brownish color in the digesting mass. One additional step only is necessary to convert the starch into sugar. Heat is not capable of producing this step in the process, but when achröo-dextrine, the last stage of heat digestion, the perfectly cooked starch is brought into contact with the saliva of any other starch-digesting ferment, the formation of sugar takes place instantaneously. In other words, by the application of heat of sufficient degree for a sufficient length of time starch may be converted first into amylo-dextrine is produced by a temperature sufficient to cause the hydration or gelatination of starch in the formation of paste by cooking of starch or flour. Longer cooking, or cooking for a short time at a temperature above the boiling point of water, advances starch one step along in the process of digestoin to the stage of erythro-dextrine. Exposed to still higher temperature for a proper length of time produces achröo-dextrine.

"Raw starch, on the other hand, when exposed to the action of the saliva is not changed at all. Slightly cooked starch, that is, amylo-dextrine or fluid starch, is converted into sugar only by the prolonged action of the saliva. Erythro-dextrine, or imperfectly cooked starch, is converted into sugar somewhat more quickly by the action of the saliva, but in achröo-dextrine, or perfectly cooked starch, the transformation takes place as soon as it is brought into contact with the saliva. It is for this reason that a brown crust of bread, zwieback, and well-toasted granose develop a distinctly sweetish taste when chewed.

> "Our modern methods of bread-making, in which the dough is formed in large masses or loaves, or small masses under the name of biscuits, buns, rolls, etc., present the starch or farinaceous elements of cereals in a half-raw, imperfectly cooked condition, prepared to interfere with digestion, rather than to promote this most important vital process. Half-cooked mushes and porridges assist in the work of mischief, and as a result, the American people have come to be almost universally afflicted with amalaceous dyspepsia, or starch indigestion. This fact explains the extensive use of malt preparations, and the recent introduction of various starch-digesting ferments or diastases of various origin, some of malt, others from vegetable fungi."

It is then to be very greatly desired that those who provide food for students should take especial care in the cooking of cereals and breads. While it is of supreme importance that whenever starch foods are eaten they should be thoroughly cooked, yet this is especially necessary in respect of the morning meal when a stomach full of half cooked starch will be a serious drawback to the student during the best hours of the day. It may as well be recognized that no matter how skillful the teaching it must fall on barren soil if it is received by those who are devoting all their strength to breaking up starch.

Foods, as for instance, Malt Breakfast Food, Granola, etc., are now being manufactured which are either subjected to the degree of heat necessary to carry starch quite a ways along in the process of conversion into dextrin, or the same end is attained by malting; and these, it seems, should be found more freely upon the tables of students than is indicated in our returns. I have, however, spent some days at one boarding house in the city where the morning cereals seemed all thoroughly cooked, and were most palatable and nutritious; but I have obtained dishes at other places where students board that were not fit for mortal man to entertain in his system. The freer use of thoroughly baked, or better still twice baked bread, is much needed in our community. In the baking of bread in the ordinary way the middle of the loaf does not rise above 212°, although the outside reaches 400° or more. Many people choose the crust for its more agreeable taste, which results from the conversion of the starch into dextrin by the action of heat in baking. It is at the same time more digestible, and so in reality more nutritious.

A word should be said respecting the cookery of one or two other common articles of food—and first, potatoes. The usual mode in our own locality is to boil them peeled and mash them. Now, one of the most valuable nutrient elements in the potato is the salts of potash, which in a jacketless potato readily escapes into the water during boiling, and especially if the tubers are placed in cold water at the outset. Jackets or no jackets then is the vital question, and we are compelled to decide in favor of the affirmative. In countries where the people cannot obtain these salts in meats and other foods, experience has taught them to cook the potatoes always without peeling. Baking, though, is altogether the most desirable mode of cooking the potato. By this method all the salts are preserved; while in boiling, even with the covers on, the potato suffers some loss. It is very evident from our returns that a reform is needed in the cooking of such a substantial and yet simple article of food as the potato.

It is probable that one of the most poorly cooked foods in our locality is the egg. The method is almost universally frying. To say nothing about the chemical changes which this produces, it is enough to point out that the albumen becoming incased in animal fat partially decomposed is well nigh invulnerable to the attacks of the digestive juices. On the other hand, anyone who has tried immersing an egg for eight minutes or so in water about twenty degrees below the boiling point and which has been taken off the stove, will know that no part of the egg is cooked hard and yet heat has penetrated throughout the whole. An egg cooked in this way is highly digestible and possesses a delicious flavor; for a morning meal it will supply the energy needed for the day's work much more speedily and with less expenditure of internal forces than a fried egg or an egg *boiled* in water at a temperature of 212°.

§3. *Hours for Meals.*—It is well known, of course, that a heavy meal makes demands upon the energies of the system for a considerable period; mind and body alike are less efficient while the early stages of digestion are in progress. The prosperity of digestion itself requires muscular repose for a time; and when three "square" meals are disposed of daily a relatively large part of waking life must be devoted to the interests of the stomach, and the head and hands must suffer thereby. It would seem a much wiser scheme, and one which is being adopted now in the cities especially, to get most of our nutrition in two repasts; and if we have a third, to make it exceedingly light so that it will not interfere seriously with either mental or physical activities. A business man in the city would not think of dining at midday; he lunches simply, and his luncheon really serves the purpose of a little recreation rather than of gaining nutrition.

Our students enjoy three meals a day, all of about the same proportions, so far as can be judged from the bills-of-fare. It is true they have at noon, with a very few exceptions, what is called dinner, and this is supposed to be the principal repast of the day, although it seems to be so only in the sense that perhaps heavier and more indigestible viands are discussed. But a large number of our students attempt their hardest work in the afternoon immediately following their experience at table; their study hours are in the majority of cases from 2 to half past 5; and it is surely not an overstatement to say that no brain is in good workable condition when handicapped by a stomach full of such things as are indicated in the midday bills-of-fare given in Chapter III. Nearly every one of our students —all except fourteen—reported that from 2 to 4 was the dullest time in the entire day. From 7 to 9 is also a period of marked mental depression. One would suppose that the mind would be worn out as the hour for retiring approached, and that it would be most obtuse then; but only eight out of the whole number of students reporting said they were dullest at bedtime; the others were stupidest after meals.

A reform in respect of the hours for gaining nutrition is assuredly needed in our community. It would seem as if the majority of those who make a business of boarding students make no business of it at all. If they were engaged in any other calling they would be obliged to minister to the well-being of those whom they served; but not so with most of the landlords and landladies who care for students. So many people seem to harbor the opinion that a student's welfare does not need special consideration anyway; it is an easy thing to study and the question of special food and appropriate times for eating is of little importance. But we need to have present practices modified so that students will at midday have a light luncheon of very digestible and nutritious foods; then at half past five or thereabouts should come a more substantial meal, perhaps the principal one of the day. It should be said in this connection that the last repast ought not to be eaten much later than this, since it is important that the digestion of this meal should be completed before bedtime. The stomach is not active during sleep, and foods remaining therein during the night are certain in most instances to pass through fermentative processes, seriously disturbing the normal functioning of the digestive system. Hardly any one can discuss a late banquet without his tongue the next morning revealing his dissipation; the germs which have been prospering during the night have installed themselves in every part of the mucous membrane which is accessible to them.

At Columbia University most of the students partake at midday of a simple luncheon of milk and bread, and perhaps a sandwich, obtained at the University refreshment stand; and after an hour's social chat, go back to their work in the library and laboratories. This seems a much more rational way than to rush headlong home to a big dinner and rush back in the same manner to recitations and other work, or escape to one's room to doze away two or three profitless hours. This gives one both a bad stomach and a bad conscience, and results eventually in an empty head. May we not hope that some day there will be near the campus of our University a refreshment booth offering the most wholesome, palatable, and nutritious foods at slight cost, so that students may spend in the library, in the laboratories, and in general social intercourse on the campus the time which is now wasted in rushing to a "square" meal and recovering from the same?

During the winter of 1892–93 an experiment was made along this line at the Boston School of Gymnastics in serving luncheons to women students at 15 cents each. The manager, Miss Wentworth, kept a record for one month of the amount of foods furnished, with their nutritive values; and while I believe more nutritious and more easily digested articles, as I have indicated in Chapters III and IV, could be furnished now than appeared in this record, yet it is suggestive regarding what could be done for students in our midst without departing in any way from established custom respecting articles of diet.

Statement of one month's luncheons served to students (women) five days in the week, beginning February 1, ending February 28. (Atkinson, op. cit.)

	Ounces.	Food Value in Grams.			Calories.
		Proteid.	Fat.	Carbohydrates.	
February 1st:					
Beef broth	9.4	2.63	20.4	128.4	817.5
Two rolls	4.0				
Gingerbread	4.0				
Butter	0.7				
February 2d:					
Baked beans	8.4	2.63	35.6	131.4	979.3
Brown bread	2.0				
One roll	2.0				
Butter	0.7				
One orange	5.5				
February 3d:					
Escalloped meat	10.0	32.2	26.8	138.8	942.2
Rolls	4.0				
Butter	0.7				
Apple sauce	5.3				
February 6th:					
Vegetable soup	9.7	20.0	20.9	92.1	648.2
Rolls	4.0				
Butter	0.7				
Apricot sauce	6.0				
February 7th:					
Potato soup	9.6	15.0	24.9	131.5	826.1
Rolls	4.0				
Butter	0.7				
Two baked apples	8.0				
February 8th:					
Pea soup	9.8	23.6	35.4	126.1	935.8
Rolls	4.0				
Butter	0.7				
Apple cake	4.0				
February 9th:					
Beef hash	6.4	33.1	24.0	136.5	911.8
Rolls	4.0				
Butter	0.7				
Apple sauce	5.3				
February 10th:					
Oyster soup	9.6	20.9	25.9	108.0	762.5
Rolls	4.0				
Butter	0.7				
Prune sauce	5.8				
February 13th:					
Beef croquettes	4.0	16.8	22.7	111.4	738.8
Potato croquettes	4.0				
Rolls	4.0				
Butter	0.7				
Baked apples	8.0				
February 14th:					
Fish chowder	10.0	22.2	30.0	101.3	778.1
Rolls	4.0				
Butter	0.7				
One orange	5.3				

Statement of one month's luncheons served to students (women).—Continued.

	Ounces.	Food Value in Grams.			Calories.
		Proteid.	Fat.	Carbohydrates.	
February 15th:					
Tomato soup	9.7	19.1	26.3	108.0	739.0
Rolls	4.0				
Butter	0.7				
Doughnuts	3.5				
February 16th:					
Escalloped fish	4.0	26.8	24.0	109.8	777.2
Rolls	4.0				
Butter	0.7				
Baked apples	8.0				
February 17th:					
Baked beans	8.4	26.3	35.6	131.4	979.3
Brown bread	4.2				
One roll	2.0				
Butter	0.7				
One orange	5.3				
February 20th:					
Corn soup	9.6	13.6	23.1	107.0	704.2
Rolls	4.0				
Butter	0.7				
Apple sauce	5.3				
February 21st:					
Beef broth	9.4	26.3	20.4	128.4	817.5
Rolls	4.0				
Butter	0.7				
Ginger-bread	4.0				
February 22d:					
Baked beans	8.4	26.3	35.6	131.4	979.3
Brown bread	4.2				
One roll	2.0				
Butter	0.7				
One orange	5.5				
February 23d:					
Escalloped oysters	4.5	24.0	34.0	115.2	880.3
Rolls	4.0				
Butter	0.7				
Buns	5.0				
February 24th:					
Tomato soup	9.7	15.0	19.5	108.4	681.8
Rolls	4.0				
Butter	0.7				
Baked apples	8.0				
February 27th:					
Potato soup	9.6	19.1	24.9	139.7	875.9
Rolls	4.0				
Butter	0.7				
Lemon jelly	6.0				
February 28th:					
Pea soup	9.8	23.6	35.4	126.1	935.3
Rolls	4.0				
Butter	0.7				
Apple cake	4.0				
Average	....	23.8	27.1	120.2	827.4

CHAPTER VI.

INDIVIDUAL PECULIARITIES IN DIGESTIVE CAPACITIES.

§1. *The Theory of Individual Differences.*—There seem to be two great forces that vie with one another in planning and directing the construction of every new being ushered into the world. The first is heredity, which seeks to reproduce without modification in the offspring the characteristics of the parents; the second is variation, which seeks to differentiate the young from their ancestors—to beget in them modified structures and functions.[1] As a result of the interaction of these forces it happens that while members of the human species, for instance, are much alike, still each is probably distinguished by some purely individual features either in the architecture of the body, in the workings of the vital machinery, or in mental tendency and capacity.[2] These differences are probably as marked in respect of digestive functions as of any other; and it is not difficult to appreciate this when it is realized that the transformation of food is brought about through the offices of various digestive fluids. Each food element has its particular digestive agent,—starch requiring a special one, albumen another, fat another. Now, it happens that people differ regarding the quantity and quality of each of these digestive agents; this person falls short on the one essential for the disposition of starch, another generates free hydrochloric acid in excess of that which is actually needed or which is conducive to the well-being of the organism, and so on. It results then that we all have our idiosyncracies regarding the articles from which we can best obtain our nutrition, and the viands we can indulge in with impunity. One who has much difficulty in dealing with starch will find it easier ordinarily to secure his albuminoids from flesh or nut foods than from the cereals or other vegetable products; although, to repeat what was urged in preceding paragraphs, by proper cooking starch may be largely pre-digested, making it acceptable to the most whimsical stomach. An acid stomach cannot tolerate sour fruits, vinegar, or other acids, while a "hypopeptic" individual enjoys and needs an abundance of fruit acids. And the principle holds in respect of many another digestive peculiarity.

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[1] Cf. Bateson, *Materials for the Study of Variation*, London, 1894, pp. 1–80. Darwin, *Origin of Species*, entire book; Höffding, *Outlines of Psychology*, p. 348, et seq.

[2] See for a discussion of individuality in the mental sphere,—Bain: *A Study of Character*, London, 1863; Ribot: *Psychology of the Emotions*, chap. XII; Paulhan: *Les Charactères;* Perez: *Caractère de l'enfant et de l'homme;* Lotze: Microcosmus, Bk. VI, chap. II; Queyrat: *L'imagination chez l'enfant;* Galton: *Mental Faculty*, chap. on Mental Imagery.

§2. *Concrete Examples.*—To impress the principle of individual peculiarities in digestive powers there will be given here graphic illustrations[1] of actual analyses of the stomach fluids of two persons of the same family securing their nutrition from the same table. The analyses were made in the Laboratories of Hygiene of the Battle Creek Sanitarium according to methods devised by Golding Bird of England and Hayem and Winter of Paris, and extended and perfected by J. H. Kellogg. In the following brief explanation of the methods of examination I follow Kellogg[2] principally. In order to make the analysis it is necessary to extract the contents of the stomach after there has been eaten a given quantity of food the composition of which is thoroughly understood; and, of course, a certain amount of time must be allowed for the action of the stomach upon the food. By chemical analyses of the stomach fluids it is then possible to determine the relative amounts of the several digestive agents, and so to calculate the working power, as it were, of the stomach, indicating whether it is normal in all respects or whether it varies therefrom in regard to any of the digestive processes. In making the test at Battle Creek the

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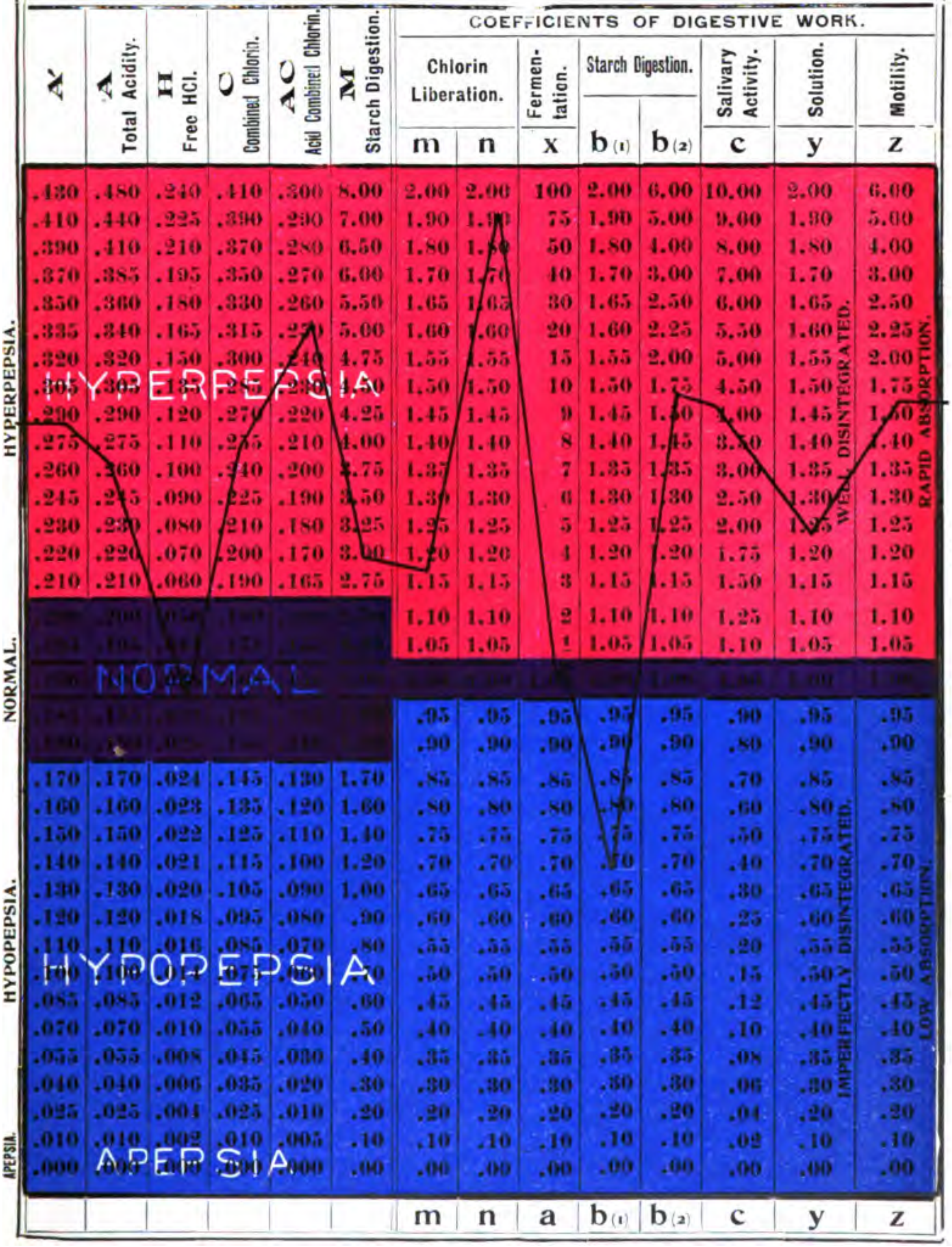
[1] I am indebted to Dr. J. H. Kellogg and The Modern Medicine Publishing Co. for the use of the plates of the charts.

[2] *Methods of Precision in the Investigation of Disorders of Digestion*—Modern Medicine Publishing Co., 1899. Also Modern Medicine Library, No. 1, May, 1896.

GRAPHIC REPRESENTATION

Of the Results of the Chemical Examination of Salivary and Gastric Digestion.

NO. 8938.

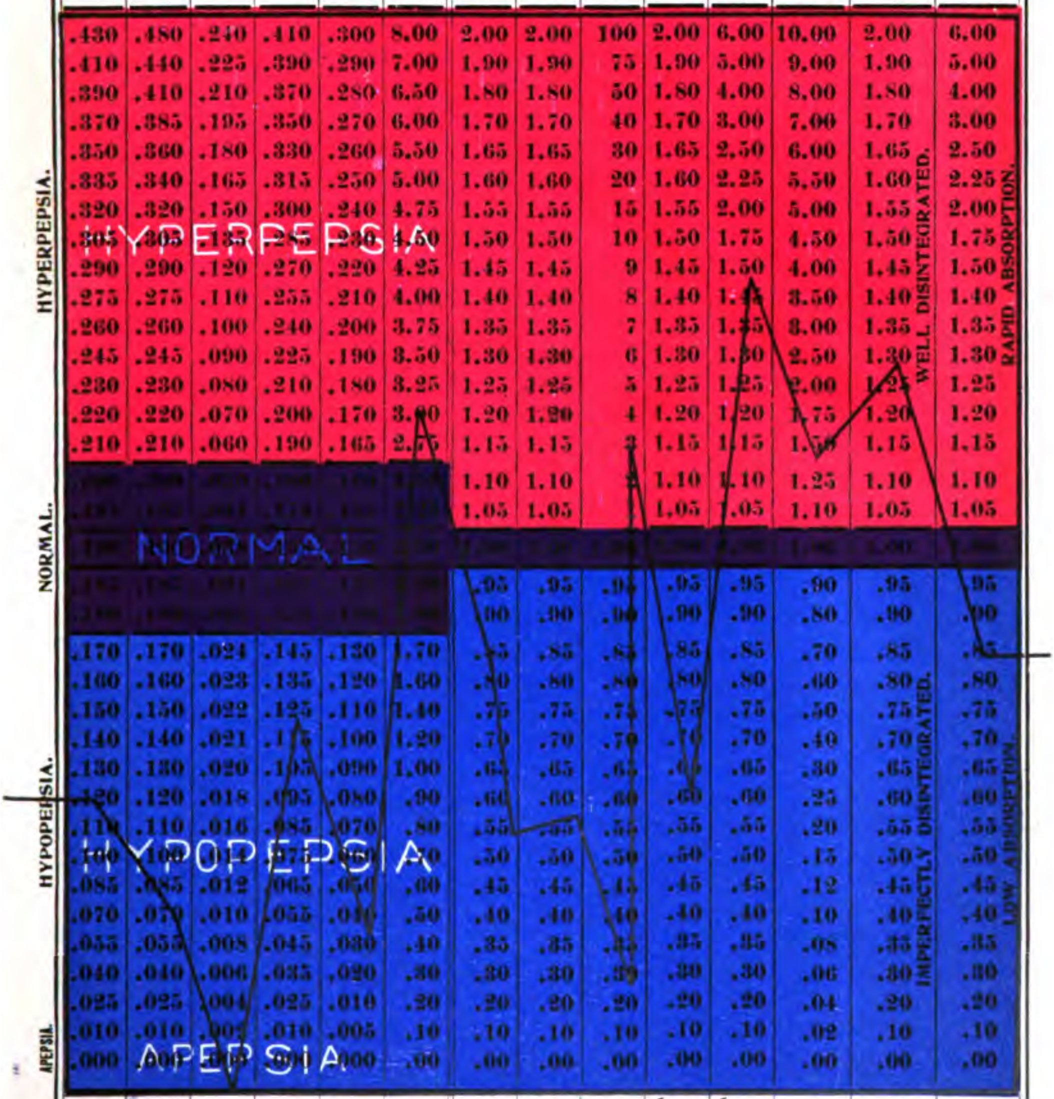


A′	A Total Acidity.	H Free HCl.	C Combined Chlorin.	AC Acid Combined Chlorin.	M Starch Digestion.	COEFFICIENTS OF DIGESTIVE WORK.							
						Chlorin Liberation.		Fermen-tation.	Starch Digestion.		Salivary Activity.	Solution.	Motility.
						m	n	x	b(1)	b(2)	c	y	z
.430	.480	.240	.410	.300	8.00	2.00	2.00	100	2.00	6.00	10.00	2.00	6.00
.410	.440	.225	.390	.290	7.00	1.90	1.90	75	1.90	5.00	9.00	1.90	5.00
.390	.410	.210	.370	.280	6.50	1.80	1.80	50	1.80	4.00	8.00	1.80	4.00
.370	.385	.195	.350	.270	6.00	1.70	1.70	40	1.70	3.00	7.00	1.70	3.00
.350	.360	.180	.330	.260	5.50	1.65	1.65	30	1.65	2.50	6.00	1.65	2.50
.335	.340	.165	.315	.250	5.00	1.60	1.60	20	1.60	2.25	5.50	1.60	2.25
.320	.320	.150	.300	.240	4.75	1.55	1.55	15	1.55	2.00	5.00	1.55	2.00
.305	.305	.135	.285	.230	4.50	1.50	1.50	10	1.50	1.75	4.50	1.50	1.75
.290	.290	.120	.270	.220	4.25	1.45	1.45	9	1.45	1.50	4.00	1.45	1.50
.275	.275	.110	.255	.210	4.00	1.40	1.40	8	1.40	1.45	3.50	1.40	1.40
.260	.260	.100	.240	.200	3.75	1.35	1.35	7	1.35	1.35	3.00	1.35	1.35
.245	.245	.090	.225	.190	3.50	1.30	1.30	6	1.30	1.30	2.50	1.30	1.30
.230	.230	.080	.210	.180	3.25	1.25	1.25	5	1.25	1.25	2.00	1.25	1.25
.220	.220	.070	.200	.170	3.00	1.20	1.20	4	1.20	1.20	1.75	1.20	1.20
.210	.210	.060	.190	.165	2.75	1.15	1.15	3	1.15	1.15	1.50	1.15	1.15
[illegible]	.200	[illegible]	[illegible]	[illegible]	[illegible]	1.10	1.10	2	1.10	1.10	1.25	1.10	1.10
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.05	1.05	1	1.05	1.05	1.10	1.05	1.05
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.00	[illegible]	[illegible]	1.00	1.00	1.00	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.95	.95	.95	.95	.95	.90	.95	.95
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.90	.90	.90	.90	.90	.80	.90	.90
.170	.170	.024	.145	.130	1.70	.85	.85	.85	.85	.85	.70	.85	.85
.160	.160	.023	.135	.120	1.60	.80	.80	.80	.80	.80	.60	.80	.80
.150	.150	.022	.125	.110	1.40	.75	.75	.75	.75	.75	.50	.75	.75
.140	.140	.021	.115	.100	1.20	.70	.70	.70	.70	.70	.40	.70	.70
.130	.130	.020	.105	.090	1.00	.65	.65	.65	.65	.65	.30	.65	.65
.120	.120	.018	.095	.080	.90	.60	.60	.60	.60	.60	.25	.60	.60
.110	.110	.016	.085	.070	.80	.55	.55	.55	.55	.55	.20	.55	.55
.100	.100	.014	.075	.060	.70	.50	.50	.50	.50	.50	.15	.50	.50
.085	.085	.012	.065	.050	.60	.45	.45	.45	.45	.45	.12	.45	.45
.070	.070	.010	.055	.040	.50	.40	.40	.40	.40	.40	.10	.40	.40
.055	.055	.008	.045	.030	.40	.35	.35	.35	.35	.35	.08	.35	.35
.040	.040	.006	.035	.020	.30	.30	.30	.30	.30	.30	.06	.30	.30
.025	.025	.004	.025	.010	.20	.20	.20	.20	.20	.20	.04	.20	.20
.010	.010	.002	.010	.005	.10	.10	.10	.10	.10	.10	.02	.10	.10
.000	.000	.000	.000	.000	.00	.00	.00	.00	.00	.00	.00	.00	.00
						m	n	a	b(1)	b(2)	c	y	z

GRAPHIC REPRESENTATION

Of the Results of the Chemical Examination of Salivary and Gastric Digestion.

NO. 11599.



	A'	A Total Acidity.	H Free HCl.	C Combined Chlorin.	AC Acid Combined Chlorin.	M Starch Digestion.	COEFFICIENTS OF DIGESTIVE WORK.							
							Chlorin Liberation.		Fermentation.	Starch Digestion.		Salivary Activity.	Solution.	Motility.
							m	n	x	b(1)	b(2)	c	y	z
	.430	.480	.240	.410	.300	8.00	2.00	2.00	100	2.00	6.00	10.00	2.00	6.00
	.410	.440	.225	.390	.290	7.00	1.90	1.90	75	1.90	5.00	9.00	1.90	5.00
	.390	.410	.210	.370	.280	6.50	1.80	1.80	50	1.80	4.00	8.00	1.80	4.00
	.370	.385	.195	.350	.270	6.00	1.70	1.70	40	1.70	3.00	7.00	1.70	3.00
	.350	.360	.180	.330	.260	5.50	1.65	1.65	30	1.65	2.50	6.00	1.65	2.50
	.335	.340	.165	.315	.250	5.00	1.60	1.60	20	1.60	2.25	5.50	1.60	2.25
HYPERPEPSIA.	.320	.320	.150	.300	.240	4.75	1.55	1.55	15	1.55	2.00	5.00	1.55	2.00
	.305	.305	.135	.285	.230	4.50	1.50	1.50	10	1.50	1.75	4.50	1.50	1.75
	.290	.290	.120	.270	.220	4.25	1.45	1.45	9	1.45	1.50	4.00	1.45	1.50
	.275	.275	.110	.255	.210	4.00	1.40	1.40	8	1.40	1.40	3.50	1.40	1.40
	.260	.260	.100	.240	.200	3.75	1.35	1.35	7	1.35	1.35	3.00	1.35	1.35
	.245	.245	.090	.225	.190	3.50	1.30	1.30	6	1.30	1.30	2.50	1.30	1.30
	.230	.230	.080	.210	.180	3.25	1.25	1.25	5	1.25	1.25	2.00	1.25	1.25
	.220	.220	.070	.200	.170	3.00	1.20	1.20	4	1.20	1.20	1.75	1.20	1.20
	.210	.210	.060	.190	.165	2.75	1.15	1.15	3	1.15	1.15	1.50	1.15	1.15
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.10	1.10	2	1.10	1.10	1.25	1.10	1.10
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.05	1.05	1	1.05	1.05	1.10	1.05	1.05
NORMAL.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.95	.95	.95	.95	.95	.90	.95	.95
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.90	.90	.90	.90	.90	.80	.90	.90
	.170	.170	.024	.145	.130	1.70	.85	.85	.85	.85	.85	.70	.85	.85
	.160	.160	.023	.135	.120	1.60	.80	.80	.80	.80	.80	.60	.80	.80
	.150	.150	.022	.125	.110	1.40	.75	.75	.75	.75	.75	.50	.75	.75
	.140	.140	.021	.115	.100	1.20	.70	.70	.70	.70	.70	.40	.70	.70
	.130	.130	.020	.105	.090	1.00	.65	.65	.65	.65	.65	.30	.65	.65
	.120	.120	.018	.095	.080	.90	.60	.60	.60	.60	.60	.25	.60	.60
HYPOPEPSIA.	.110	.110	.016	.085	.070	.80	.55	.55	.55	.55	.55	.20	.55	.55
	.100	.100	.014	.075	.060	.70	.50	.50	.50	.50	.50	.15	.50	.50
	.085	.085	.012	.065	.050	.60	.45	.45	.45	.45	.45	.12	.45	.45
	.070	.070	.010	.055	.040	.50	.40	.40	.40	.40	.40	.10	.40	.40
	.055	.055	.008	.045	.030	.40	.35	.35	.35	.35	.35	.08	.35	.35
	.040	.040	.006	.035	.020	.30	.30	.30	.30	.30	.30	.06	.30	.30
	.025	.025	.004	.025	.010	.20	.20	.20	.20	.20	.20	.04	.20	.20
APEPSIA.	.010	.010	.002	.010	.005	.10	.10	.10	.10	.10	.10	.02	.10	.10
	.000	.000	.000	.000	.000	.00	.00	.00	.00	.00	.00	.00	.00	.00
							m	n	a	b(1)	b(2)	c	y	z

subject is required first to abstain from all food for ten or twelve hours; and he is then given to eat a bowl of Granose, a dry wheat product. He is not allowed any fluids at this test meal. After one hour the contents of the stomach are extracted and subjected to physical and chemical examination. The chemical examination reveals, to begin with, the amount of chlorine present in different forms, which determines the acidity of the stomach and so the power of proteid digestion. This analysis reveals three main types of digestive disorder,—hyperpepsia, hypopepsia, and apepsia. Speaking in a general way, hyperpepsia denotes an excessively acid stomach, hypopepsia a stomach in which there is not enough of acid for proper digestion, and apepsia a stomach in which there is almost no native power of proteid digestion. These types of stomachs are indicated in the charts by the different colored areas, the red denoting the hyper-acid stomach, so to speak, and the blue the sub-acid stomach.

The test for chlorine in its different combinations shows, in the first place, the total acid condition of the stomach, which is denoted in the chart by *A*. Taking a given quantity of stomach fluid, usually 100 cubic centimeters, it has been determined that the normal amount of acid ranges from .180 to .200 grams. This is indicated in the chart by the purple area, denoting that a stomach containing this proportion of acid is normal in its digestive power. Then the figures above and below the normal area denote the relative proportion of excess or lack of acidity. The column headed *H* denotes the amount of free hydrochloric acid which has been found in the quantity of stomach fluid examined. It is calculated that the normal amount in 100 cubic centimeters of stomach fluid ranges from .025 to .050; all quantities above this amount are excessive, those below are insufficient for proper digestion. The column headed *C* denotes the amount of combined chlorine; that headed *A′* indicates the amount of free hydrochloric acid and combined chlorine taken together. A′ represents the quantity of work, without reference to quality, which the stomach does.

Now, by referring to the two charts it can be seen that No. 8,938 possesses what may be called an acid stomach. Column A' which denotes the working power of the stomach, shows that it is excessive, which means that the food which is eaten is not likely to be fully assimilated; it is disposed of too rapidly. On the other hand, No. 11,599 possesses a sub-acid stomach, where the proteid digestion is defective; the free hydrochloric acid is seen to be especially lacking. In prescribing a diet for these two individuals a physician would say that No. 8,938 should abstain from acids in every form, while No. 11,599 is much in need of acid that can be obtained in fruits. I happen to know as a matter of act that if No. 8,938 drinks a glass of lemonade it will cause distress, while No. 11,599 is greatly benefited by lemonade used very freely. The first subject cannot eat sour apples with impunity, while the second subject is very greatly benefited by their generous use. No. 8,938 likes foods rich in proteids, probably because they are easily digested; while No. 11,599 is not so fond of beans and similar foods containing a large proportion of albumen. If No. 8,938 drinks a glass of milk between meals he finds it difficult of digestion, doubtless because the excessive acidulous condition of the stomach causes coagulation of the casein before the digestive juices can act upon it in a proper way. No. 11,599 does not apparently experience inconvenience from a glass of milk at any time.

The analysis of stomach fluid reveals other digestive characteristics than those already discussed. It will be seen by an examination of the charts there is a column headed S in one case and M in the other in which is represented the capacity for starch digestion. This is determined by ascertaining the percentage of maltose, expressed as dextrin, found present in the stomach fluid. The normal amount in 100 cubic centimeters ranges from 1.80 to 3.00. (The charts do not quite agree here, due to the fact doubtless that the normal amount has been found to be different as a result of more extended analyses. As the analysis of No. 11,599 was made last, however, it is probable that it represents more correctly the normal amounts, which would then range from 1.80 to 2.50 grams.) Quantities above or below these figures indicate a defect in digestive power. While No. 11,599 is sub-normal in proteid digestion, he is hyper-normal, if the term will be allowed, in starch digestion. No. 8,938 shows excess work here as in the case of proteid digestion.

As an outcome of these examinations it is possible to determine the working power of the stomach in various directions, and the results are indicated in the charts by coefficients of digestive work. It can be seen that No. 8,938 does excessive work in respect of the liberation of chlorine during the digestive processes, indicated by the tracing in the columns *m* and *n*. No. 11,599 is quite deficient in this regard. The coefficient of proteid digestion is *a*, and this power is shown to be normal in the acid but deficient in the hypopeptic stomach. The coefficient of fermentation is *x*, which is shown to exist in the case of No. 11,599 but not in the other instance. The coefficients of starch digestion are of two kinds: b_1, which denotes the relation of the perfectly digested starch or maltose found in the stomach fluid to the dextrin and soluble starch which is imperfectly digested or converted; and b_2, which has reference to the amount of maltose or perfectly digested starch to the amount found in normal digestion. No. 8,938 is sub-normal in the first sort of digestion, and hyper-normal in the second; and substantially the same condition is found in the other stomach. The power of salivary activity is represented by the coefficient *c*. This is determined in the experiment by requiring the subject to chew gum for a given length of time, the saliva secreted being collected and examined. The column headed *y* relates to the digestive activity of the stomach with reference to the power of disintegrating the food substances; it is determined by comparing the undissolved residue of the fluid with the total amount of stomach fluid obtained. In both stomachs there is less than the normal amount, which shows excessive activity in this respect. Finally the examination shows the rapidity with which the stomach fluid is disposed of. The coefficient *z* refers to this digestive capacity, and is obtained by a comparison of the amount of residual fluid found in the stomach at the end of the first hour of digestion after a test meal with the normal amount. It can be seen that in No. 8,938 the food is hastened too rapidly, while in No. 11,599 absorption does not proceed rapidly enough.

It must be apparent then that these differences in digestive capacity advise somewhat different practices with respect to the quantity and quality of foods eaten; but the most marked difference between the stomachs is that relating to the digestion of proteids, one individual needing to augment the natural supply of acid in order to promote the digestive process, while the other is embarrassed by the too bounteous gifts of nature.

CHAPTER VII.

EXPENSE OF DIETARIES.

§1. *Taste Versus Expense in the Choice of Foods.*—In an older day men lived to eat; the gratification of the palate was the *summum bonum* of life. But the times have changed; life is now seen to be more real and earnest and the table is not its goal. But yet there are those among us who, while holding to the higher and more spiritual ends of existence, still believe that food should be chosen with reference to its taste, to its aesthetic qualities, so to speak, rather than for its nutritive properties. "Eat what you like," these people say; "this business of seeing how you can get the greatest nutrition for the least amount of money is unworthy cultured beings." Such persons select their meats, their breads, and their wines primarily because they are agreeable to the palate. Among some, the choice of food upon this principle has developed into a fine art. As great pains are taken in planning a bill-of-fare as in painting a picture;—there must be as great harmony of gustatory sensations in the one as of visual sensations in the other. The question of value for money expended does not enter into the construction of a dietary at all with these neo-Epicureans.

Now, it seems to be a law of our being that what is indifferent, painful, or repugnant cannot exercise a beneficial influence upon us; that alone which is pleasureable seems to heighten the tide of life. It is probable, too, that of all manner of obnoxious things distasteful food is the worst; and so there is really a show of reason in the doctrine, eat what you like. But upon close examination it does not go very far; it assumes that there is incompatibility in deferring to the pocket-book and to the palate at the same time. The conviction seems to be deeply settled in many people's minds that what is nutritious is not tasty; and what is palatable may or may not have any nutritive value, usually not. As a matter of fact, however, common sense would suggest that what is best for the organism in the long run affords the most agreeable gustatory sensations. The palate never would have survived in the crisis of evolution if it had not thus served the body faithfully. If in its pristine condition it selected foods which, while ministering to taste yet were of little account in meeting the needs of existence, the race would have disappeared in its infancy. Evolution, then, confirms what unprejudiced observation and personal experience will tell anyone,—that the most palatable foods fulfill the requirements of perfect nutrition most satisfactorily.

§2. *The Cost of a Dietary of Different Foods.*—But however the philosophy presented in the preceding section may be regarded by some, yet it will readily be granted by all that in student life, as it is found in our community, the question of securing nutrition at the least expense is a vital one. Considerably over one-half of our students feel the need of economizing in every direction during their university career, and it is probable that there is no place where wise economy would be more effectual than in the arrangement of the dietary. This may be accomplished, and I believe without doing violence in any way to the legitimate rights of the palate. There are appended tables showing that the requirements of a perfect bill of fare can be met with different foods at greatly varying expenditures. To illustrate: If one had twenty-five cents to expend for food, it would purchase for him almost no nutrition in oysters, for instance, but it would yield very large returns if spent for bread, or oatmeal, or cornmeal, as the following figures show:

Amounts of nutrients furnished for twenty-five cents in food materials at ordinary prices. (Atwater, op. cit., p. 28.)

FOOD MATERIALS AS PURCHASED.	Price per pound.	25 CENTS WILL PAY FOR:					
		Total food materials.	*Nutrients.* Total.	Protein.	Fats.	Carbohydrates.	Fuel value.
	Cents.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Calories.
Beef, sirloin	10	2.50	.79	.38	.41	....	2,425
Beef, sirloin	15	1.67	.52	.25	.27	....	1,620
Beef, sirloin	20	1.25	.39	.19	.20	....	1,215
Beef, sirloin	25	1.00	.31	.15	.16	....	970
Beef, round	8	3.13	.95	.56	.39	....	2,675
Beef, round	12	2.08	.63	.37	.26	....	1,780
Beef, round	16	1.56	.47	.28	.19	....	1,335
Beef, neck	4	6.25	1.85	.98	.87	....	5,500
Beef, neck	6	4.17	1.23	.65	.58	....	3,670
Beef, neck	8	3.13	.93	.49	.44	....	2,755
Mutton, leg	8	3.13	.96	.47	.49	....	2,925
Mutton, leg	14	1.79	.55	.27	.28	....	1,675
Mutton, leg	20	1.25	.38	.19	.19	....	1,170
Ham, smoked	10	2.50	1.23	.37	.86	....	4,340
Ham, smoked	16	1.56	.77	.23	.54	....	2,705
Salt pork	10	2.50	2.09	.02	2.07	....	8,775
Salt pork	14	1.79	1.50	.02	1.48	....	6,285
Salt pork	18	1.39	1.16	.01	1.15	....	4,880
Cod, fresh	6	4.17	.45	.44	.01	....	855
Cod, fresh	10	2.50	.27	.27	....	.. ....	510
Cod, dry salt	6	4.17	.68	.67	.01	....	1,315
Cod, dry salt	8	3.13	.51	.50	.01	....	985
Mackerel, salt	10	2.50	.74	.37	.47	....	2.275
Mackerel, salt	15	1.67	.49	.24	.25	....	1,520
Oysters, 25 cents a qt	12.5	2.00	.24	.13	.03	.08	520
Oysters, 35 cents a qt	17.5	1.43	.17	.09	.02	.06	370
Oysters, 50 cents a qt	25	1.00	.12	.06	.02	.04	260
Eggs, 15 cents per doz	8.8	2.84	.63	.34	.29	....	1,860
Eggs, 25 cents per doz	14.7	1.70	.37	.21	.17	....	1,115
Eggs, 35 cents per doz	20.6	1.21	.27	.15	.12	....	790

Amounts of nutrients furnished for twenty-five cents in food materials at ordinary prices.— Continued.

FOOD MATERIALS AS PURCHASED.	Price per pound.	25 CENTS WILL PAY FOR:					
		Total food materials.	*Nutrients.* Total.	Protein.	Fats.	Carbohydrates.	Fuel value.
	Cents.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Calories.
Milk, 3 cents per qt	1.5	16.67	2.05	.60	.67	.78	5,420
Milk, 6 cents per qt	3	8.33	1.02	.30	.33	.39	2,705
Milk, 8 cents per qt	4	6.25	.77	.23	.25	.29	2,030
Cheese, whole milk	12	2.08	1.36	.59	.74	.03	4,305
Cheese, whole milk	15	1.67	1.09	.47	.59	.03	3,455
Cheese, whole milk	18	1.39	.91	.39	.49	.03	2,875
Cheese, skim milk	6	4.17	2.25	1.60	.28	.37	4,860
Cheese, skim milk	8	3.13	1.69	1.20	.21	.28	3,645
Cheese, skim milk	10	2.50	1.35	.96	.17	.22	2,910
Butter	15	1.67	1.45	.02	1.42	.01	6,035
Butter	25	1.00	.86	.01	.85	....	3,615
Butter	35	.71	.61	.01	.60	....	2,585
Sugar	5	5.00	4.89	....	....	4.89	9,100
Sugar	7	3.57	3.50	....	....	3.50	6,495
Wheat flour	2	12.50	10.87	1.37	.14	9.36	20,565
Wheat flour	2.5	10.00	8.70	1.10	.11	7.49	16,450
Wheat flour	3	8.33	9.24	.91	.09	6.24	13,705
Wheat bread	3	8.33	5.56	.73	.14	4.69	10,660
Wheat bread	5	5.00	3.34	.44	.08	2.82	6,400
Wheat bread	8	3.13	12.09	.28	.05	1.76	4,005
Corn meal	2	12.50	10.45	1.15	.47	8.83	20,565
Corn meal	3	8.33	6.97	.77	.32	5.88	13,705
Oatmeal	3	8.33	7.51	1.22	.59	5.70	15,370
Oatmeal	5	5.00	4.52	.74	.36	3.42	9,225
Rice	5	4.17	3.64	.31	.02	3.31	6,795
Rice	8	3.13	2.73	.23	.01	2.49	5,100
Beans	0.75	5.00	4.22	1.16	.10	2.96	8,075
Potatoes, 45 cents per bush	9.75	33.33	5.70	.60	.03	5.07	10,665
Potatoes, 60 cents per bush	1	25.00	4.27	.45	.02	3.80	8,000
Potatoes, 90 cents per bush	1.5	16.67	2.85	.30	.02	2.53	5,335

§3. *Local Expenses, With Practical Suggestions.*—The average expense for table board in our community, as reported by 326 students, is $2.74. Some students pay $4.00, a few pay $1.00, the majority come very near $2.50. This is about the figure reached in the experiments made at the Maine State Agricultural College.[1] If abundant nutrition were obtained for this amount, it would probably not be excessive; although it is much greater than is necessary if a person finds it desirable to economize rigidly. Atkinson[2] has calculated bills-of-fare which afford ample nutrition and give variety, but which do not exceed in cost $.96 a week. Atwater's dietary lists at exceedingly moderate prices have already been given.[3] At the Battle Creek Sanitarium there are in the neighborhood of one thousand helpers living very well on $.75 a week or less; and there is no body of people to be met anywhere who appear better nourished, or who manifest greater efficiency in body and mind. It is certainly not overstating the case to say that our students, regarded in the whole, could live very much better than they do for the amount which they expend; and many of them who deprive themselves of social advantages for pecuniary reasons might a great deal better economize in their food with profit to their pockets and their stomachs. Of course it is impossible in the majority of instances for a single person to inaugurate reform; but where a hundred men are banded together in a club, a little planning, a little intelligent study of the problems involved, such as they would expect to do if it were any other matter under the sun, would be of tremendous advantage to them. Perhaps the day may come some time when the man who essays to manage a club or boarding house will bear some credentials testamentary of his fitness for this business other than that he is a "hustler," or is in need of money, or can find nothing else to do.

If one were to suggest methods of economy, he would first attack the meat which is found in students' dietaries, for this is the most costly of all articles of food, as Jordan[1] and many another experimenter have found.[2] It can be readily seen that to raise wheat and corn and then feed them to cattle must make the product more expensive than to use the grains in their original form for human food. The process of passing corn through cows and hogs before it reaches man involves time and labor and waste which the consumer of flesh must pay for. Paley[3] wrote as follows upon this subject some time ago:

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[1] Jordan, op. cit.

[2] Op. cit., pp. 175 et seq.

[3] Chap. III.

> "In England, notwithstanding the produce of the soil has been considerably increased by the enclosure of wastes, and the adoption, in many places, of a more successful husbandry, yet we do not observe a corresponding addition to the number of inhabitants, the reason of which appears to me to be the more general consumption of animal food amongst us. * * * If we measure the quantity of provision by the number of human bodies it will support in due health and vigor, this quantity, the extent and quality of the soil from which it is raised being given, will depend greatly upon the kind. For instance, a piece of ground capable of supplying animal food sufficient for the subsistence of ten persons, would sustain at least the double of that number with grain, roots, and milk."

Dr. Richardson, in "Modern Thought" for July, 1880, develops this thought in an interesting way. He says:

> "We really ought to consider the question of utilizing, on a large scale, all vegetables which, in nutrient value, stand above animal products. We have also to learn, as a first truth, the truth that the oftener we go to the vegetable world for our food, the oftener we go to the first, and, therefore, to the cheapest source of supply. The commonly accepted notion that when we eat animal flesh we are eating food at its prime source cannot be too speedily dissipated, or too speedily replaced by the knowledge that there is no primitive form of food—albuminous, starchy, osseous—in the animal world itself, and that all the processes of catching an inferior animal, or of breeding it, rearing it, keeping it, dressing it, and selling it, mean no more nor less than entirely additional expenditure throughout for bringing into what we have been taught to consider an acceptable form of food the veritable food which the animal itself found, without any such preparation, in the vegetable world."

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[1] Loc. cit.

[2] See, for instance, Atwater, op. cit., p. 23; also Smith, quoted by Kingsford, *The Perfect Way of Diet*, p. 103.

[3] *Principles of Moral and Political Philosophy.*

Dr. Lyon Playfair, the well known English scientist, prosecuted a series of official investigations for several years on the subject of military rations in England, France, Prussia, and Austria. He found that in order to obtain the right amount of albuminous matter it would be necessary to consume weekly:

	Price (about) s.	d.
147 ounces of butchers meat	6	1
or 93 ounces of cheese	8	0
or 341 ounces of ordinary white bread	2	8
or 175 ounces of oatmeal	1	4
or 127 ounces of dried peas	1	2

In order to obtain the necessary proportion of dynamic or caloric-forming substance, it would be necessary to consume weekly:

	Price (about) s.	d.
416 ounces of butcher's meat	17	4
or 224 ounces of cheese	7	0
or 298 ounces of ordinary bread	2	8
or 616 ounces of potatoes	2	9
or 221 ounces of dried peas	1	10
or 183 ounces of oatmeal	1	0

These figures, with others given on preceding pages, show conclusively that meat is not an economical food from which to obtain the energy required for either mental or physical labor.

Herbert Spencer, when considering some years ago the advisability of living more largely upon a vegetable diet,[1] complained that it was impossible to get the requisite amount of albumen without too much energy being expended in digestion. This objection is assuredly an important one. It has already been said that to overburden the system with innutritious, indigestible and largely waste materials results in a limitation of its efficiency; and when the albuminoids cannot be easily obtained in peas, beans, grains, and nuts the additional expense for meat in student dietaries is certainly justified. But I maintain what has already been urged, that right cooking and the freer use of pulse and nut foods and grains, as cereals and breads, rich in albumen will give us this element in as digestible and concentrated form as can be obtained in meat, and this will enable the student to economize considerably in his dietary.

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[1] *Education*, p. 240.

Another direction in which economy can be secured is in the total abolition of pies, cakes, pickles, and the like. They really serve no useful purpose in the dietary; nutritious foods will minister to the appetite just as fully and will in addition recompense the eater for his financial outlay.

CHAPTER VIII.

FRESH AIR, EXERCISE AND REST IN THE PRODUCTION AND EXPENDITURE OF CEREBRAL ENERGY.

§1. *Function of Oxygen in the Organism.*—Many people seem to think that albumen, fat, and carbohydrates are sufficient in themselves to supply the organism with energy; if you eat enough, they say, you will be vigorous enough in mind and body. But a little reflection will teach one that fat and carbohydrates as such are only force *in potentia,* so to speak. They are absolutely powerless in the system until they are oxydized, so that an adequate supply of oxygen is as essential to proper nutrition, in the broad sense, as a liberal quantity of carbohydrates and other substances. An organism deprived of a due allowance of oxygen becomes lethargic; and if it be altogether cut off, entire absence of action supervenes, a fact with which everyone is of course familiar.

Now, observation and experiment have indicated somewhere near the amount of oxygen which the human body requires for greatest efficiency, and this must be secured by a constant apportionment of air containing the "life giving element" in a certain uniform proportion. In determining this proportion the ratio of CO_2 to the other constituents of an atmosphere is usually taken as an index of the purity of that atmosphere, since this gas is generally found in the presence of other gases which vitiate the air. It has been calculated that more than 4 parts of carbonic acid gas in 10,000 parts of air renders the latter incapable of furnishing oxygen to the system in the required quantities.[1] This estimate can be only relatively true, however, since organisms differ respecting the amount of oxygen which they need to support mental and bodily activities. A high-strung individual, as we say—one who is intense in thought and quick and vigorous in physical movements—must needs generate more vital force than a person of an opposite temperament. Again, one possessing a relatively large inhalant system can thrive in an atmosphere where a small-lunged unfortunate would be able to do little more than keep body and soul together.

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[1] For the results of investigations relating to this subject, see Burnham, Pedagogical Seminary, June, 1892, p. 23, et seq.

But for the average individual it is essential in order that he may obtain the necessary quota of oxygen that there should be furnished him about 30 cubic feet of air per minute; and this with the ordinary methods of ventilation will necessitate about 225 cubic feet of space[1] being set apart for his sole tenantage. These figures can only be suggestive, since the volume of space demanded depends upon the rapidity with which the air changes and upon its richness in oxygen. But taking these estimates as of general trustworthiness, we find that the majority of our students are fairly well circumstanced in respect of elbow room in their living quarters. In our questionnaire we asked for the size of their apartments, with the number of persons they contained, and the following table presents the results:

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[1] Martin (*Human Physiology*, p. 377) says that an individual should be supplied with 800 cubic feet of space; but it is probable that this is not at all essential in properly ventilated apartments. Burnham, *op. cit.*, summarizes the results of investigations upon this subject as follows: "According to M. de Chaumont, at the International Congress of Education at Brussels in 1880, Belgium prescribed one square meter of floor-space and 4.5 cubic meters of air-space to each scholar; but the Educational League of Belgium, in the plans of its model schools, proposed 1.67 sq. m. of floor-space and 9.6 cu. m. of air-space to each pupil. In Holland the average per head was 4.54 cu. m. In England, in the Board Schools, aoout 1 sq. m. of floor-space and from 3.65 to 4.25 cu. m. of air-space were allowed. Bavaria prescribed 3.9 cu. m. for scholars of eight years, and 5.6 cu. m. for those of twelve years. In Sweden, in the primary schools 1.52 sq. m. and 5.35 to 7.55 cu. m.; in the higher schools 2.17 sq. m. and 7.69 to 9.98 cu. m. per head were allowed. In Switzerland the regulations vary in different cities. In Berne a subcommittee of the Police Directors reported two or three years ago in favor of 4 cu. m. per pupil under ten, 5.5 cu. m. for pupils over ten; in all cases 1 sq. m. of floor-space. In some schools as much as 6.50 cu. m. of air-space per child is required. In Austria 0.6 sq. m. and 3.8 to 4.5 cu. m. are required. In the country schools in Prussia a floor-area for each pupil of at least 0.64 to 0.74 sq. m. and a height of 3.20 m.—therefore at least 2 to 2.37 cu. m. of air space—are provided. In the higher schools from 3.9 to 5.2 cu. m. are required. In Wurtemberg from 3 to 5 cu. m., in Hesse and Baden 3 cu. m. are prescribed for each pupil."

No. in room.	Smallest.	Largest.
1	9½ x 9 x 8	16 x 14 x 8
2	12 x 15 x 9	24 x 12 x 8
3	10 x 12 x 8	12 x 16 x 8

It is apparent at a glance that so far as breathing space alone is concerned our students are on the whole well off. But the method of heating determines in largest degree the oxygen value of the atmosphere of any room which is much used. One heated by steam, with no provision for the entrance of fresh or the exit of expired air, is quite certain to be improperly oxygenated, be it ever so spacious; and people living therein are likely to experience sooner or later a decrease in their energies. About one-third of our students reported that their rooms were heated by steam, over one-half were favored with hot air, while fifty-four were kept warm in the old-fashioned way, by coal and wood stoves. It is probable that the most satisfactory method of heating, regarded from the point of view from which we are considering the subject, is by hot air, where the wholesomeness of the atmosphere is more easily secured. On entering a house in winter it is not difficult to detect whether it is heated in this or in some less hygienic manner. It may be added here by way of exhortation that students occupying apartments heated by steam or by stoves must give especial attention to ventilation. And this is as necessary at night as during waking hours; for it seems, as Richards says,[1] that during sleep the organism stores up oxygen which is to be utilized in generating force for the activities of the following day.

The effect of inadequate ventilation is readily apparent in lessened vigor of mind and body, and there can be no doubt that mental acumen and endurance in some cases, and lethargy and dullness in others, find their explanation in the quality of air habitually inspired. It may be remarked in passing that this subject needs attention from university authorities as well as from students themselves. A class-room filled full of seekers after knowledge, and which retains from day to day the respiratory contributions of its occupants, is, to say the least, a poor mount on which to entertain the Muses. Libraries in which the atmosphere is rarely changed furnish occasion for idle and even stupid gazing at books; one cannot drink deeply at the Pierian spring in such a place. Morrison[1] has well said that in a comfortable atmosphere of proper temperature and purity as much labor can be accomplished in one hour as can be accomplished in six hours in an atmosphere rendered impure by respiration.

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[1] The Northwestern Monthly, Vol. VIII, July, '97.

§ 2. *Exercise.*—Doubtless every one is familiar with the most important effects of physical exercise upon the somatic functions. Hygiene has taught us these many years that muscular activity quickens circulation, stimulates the organs of elimination, arouses lethargic cells in all parts of the body, creates a need for oxygen which results in increased respiration; and, in short, produces a general feeling of euphoria, of well-being, which must be of distinct advantage to the organism from whatever point of view it is regarded. That which heightens the tide of life as a whole must be considered as fostering more vigorous and efficient mentation; so that if exercise produced directly only physiological effects in the organism, it would still be of inestimable benefit to the mind. But there are other ways in which it is of marked advantage to the mental life. For one thing, it relieves muscular tensions which sap the vitality of the physical medium of mind, a matter which will be discussed at length later.[2] The point which must receive special attention here relates to the value of exercise in promoting metabolism in the cerebral motor areas, and hence in augmenting the total energy-producing capacities of the brain. According to a now prevalent view of which Flechsig[3] is the most illustrious exponent, energy generated in one nerve center may in a well organized brain be utilized in a different one; thus I may be producing a large amount of force in the motor areas of my brain but be employing it in the reflective, the thought regions. If I exercise any certain parts of the cerebrum more than others, energy tends to flow into them and out of the unused areas. Cerebral energy may not inappropriately be likened to water in respect of its tendency to seek a level; if it be drawn out in one quarter, it will rush in from others to preserve the equipoise. This theory, which is in harmony with our knowledge of the structure of the cerebrum as an instrument for the production and transmission of energy, is also corroborated by the familiar experience of inhibition in daily life. Every one must have observed that when he thinks vigorously, the degree and force of physical action is lessened; and, on the other hand, when the muscles are most active the mind is relatively inert. Now, it seems to be a rational supposition that mental activity inhibits physical activity, because it draws away from the motor centers energy required for muscular action. When the mathematical part of the brain, for instance, is intensely active, we may conceive that energy from other localities sets in toward this as a focus, and so activity in other regions is lessened; all is expended upon the particular undertaking in hand.

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[1] *The Ventilation and Warming of School Buildings.*

[2] Chap. X.

[3] See *Gehirn und Seele.* See also Curtis: Inhibition, Pedagogical Seminary, Vol. VI, No. 1; Burk, *op. cit.*, and Newsholme, *School hygiene*, Chap. XII.

Now, if this theory be valid, an inference may be drawn from it of vital significance in regard to the value of exercise for brain workers. If the cerebral motor areas be maintained in a vigorous condition; if the metabolism of the cells be kept at its best, that is to say, then the surplus energy generated here may be utilized in intellectual labor. On the other hand, one who does not use his muscles, who does not stimulute the motor cells, fails to make use of great laboratories for the production of vital force. A student who, desiring to accomplish the most in his studies, denies himself all physical exercise must, according to our theory, be a loser in the end. And in more ways than one. He not only fails to keep in their prime all the energy-generating powers of the brain, but he really breaks up the unity between intellectual and motor activities which seems to be essential for the best mental health and balance. A certain amount of motor activity is without doubt necessary for the stability and integrity of mind, and this is becoming more apparent every day as the pathological aspects of psychology are being more carefully examined.[1] On account of this close relationship between mental and motor activity, it is probable that at no time in life can one divorce them entirely with safety to either mind or body.

The question respecting the amount of exercise which is most suitable for students is a vital one. In the present state of our knowledge it is impossible to give a definite answer to this; about all that can be said now is that each person must test the matter for himself, taking for his guide the principle that his physical activities should serve the purpose of keeping the organism in proper repair and furnishing energy to sustain mental effort. In so far as it fails to do this, it must be regarded as of little value, and it may be distinctly detrimental. If one's experience in the gymnasium or out of doors lessens the capacity for sustained mental effort, it shows that it is either excessive or not adapted to the needs of the individual. If one will become conscious of the matter for a time, he can doubtless make a rule fairly well adapted to his peculiar necessities.

While it is probable that many students in our university do not have exercise enough, yet it is certain that some have too much for the best intellectual work. I have been able to observe with some care for one year the mental processes of one of our athletes. During the fall he was under heavy training, and throughout the whole of that period he was less keen, vigorous, and sustained than usual in all of his intellectual labor. He could not reason well, was not quick in apprehending a point, was not ready in retaining or recalling what had apparently been mastered from day to day. Two or three weeks after the athletic season had closed his mind brightened up considerably, showing improvement in every direction. I conversed with him frequently regarding his mental performances, and he was conscious himself that undue physical exertion occurred at the expense of intellectual acumen and vigor.

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[1] Cf. Seguin: *The Treatment of Idiocy by the Physiological Method;* cf. also Wey, quoted by Hancock, *A Study of Motor Ability,* Ped. Sem., Vol. III, p. 24; Burk, *op. cit*; Oppenheim, *op. cit.*, chap. V.

It may appear to some who read the above paragraph that it conflicts with the popular belief that athletes make the best scholars. I am inclined to think that an athletic student who does not go beyond bounds in his training for contests is likely to be superior in his mental tasks, since he has more energy which can be employed in this direction if he will only reserve it in right measure for that purpose. It is easy to see then why a good athlete should attain high rank in scholarship in the long run, and at the same time do poor work while under training. When he does give himself up fully to his studies, he can accomplish more than the general run of folks and so keeps up his average; but if he continues in severe training throughout the whole year, I think it is altogether unlikely that he will attain fame in things of the mind.

Our students vary a good deal in the amount of exercise which they take. Twenty say they spend one hour a day in the gymnasium, forty-eight spend two hours, and thirty-four spend three hours. In many of the answers it was impossible to tell whether exercise was taken every day or only on special days in the week. A majority of our students reporting spend more time out of doors than in the gymnasium. One hundred and thirty-three spend about an hour a day out of doors, eighty-three spend two hours, and forty-two are in the open air three hours a day. If one should hazard an opinion upon the practices of our students, he might say that those who take exercise systematically have probably on the average enough to meet their needs. One hour a day of quite vigorous exercise out of doors or in the gymnasium will probably, for the majority of individuals, serve to stimulate beneficially all the organs of the body, to eliminate waste materials, and to keep the motor centers in a healthy, active condition.[1]

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[1] cf., for instance, Newsholme, *loc. cit.*

The particular form of exercise best suited to head workers is a very important matter. Regarded from our point of view, that kind of physical activity will be most efficient which keeps the cerebral motor areas in best repair, and which involves the least dissipation of vital forces. Now, it seems to be a principle of our human nature that what we like to do is in general better for us than the things we hate. Pleasurable activities create less wear and tear[1] than those which are distasteful, an arrangement we should infer from the principles of evolution, even if we had no confirmatory experience with it in our own lives. Disagreeable tasks lie along the lines of greatest resistance for the organism, so a relatively larger amount of energy must be expended in overcoming them; while on the other hand, what is agreeable opens up ways of easy progress, and makes comparatively little demands upon our powers. This doctrine is of vital consequence in relation to our physical exercise. Games and plays and gymnastics which are pleasurable will accomplish the purpose of recreation better than those which are indifferent or boresome. A game which will enlist our lively interest will do much more for us than formal drill which we have to coerce ourselves through. In other words, play, in the best sense of the term, whether in the gymnasium or out of doors, constitutes by all odds the most efficient method of exercise;[2] it usually involves the various organs of the body and utilizes highly co-ordinated and complex activities, so that all parts of the motor mechanism of the brain are brought into action. "Man is wholly man only when he plays," Schiller says. On the other hand, formal drill ofttimes makes use of only a few movements and so stimulates but small portions of the cerebral motor areas.

Again, so far as possible the will should be released in physical exercise. This is accomplished more largely in play than in drill which one dislikes; things which we hate we have to will to overcome, while those activities which draw us spontaneously do not require for their execution an act of volition. Observe a boy at play and at work. The play may really be harder in the sense that more work is done and more difficult movements are performed, but yet his will is not exerting itself against obstacles and so he is really less fatigued over the heavier than the lighter task. And so it is with all of us; we tire much more readily in performing tasks in which we have no interest. Economy then demands that a student's physical exercises be genuinely pleasurable; that he go to them without having to drive himself. Recreation will then accomplish the purpose for which it is taken, rather than become an additional burden to an already overtaxed will.[1]

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[1] cf. Johnson: *Education in plays and games;* Ped. Sem., Vol. 3, pp. 98 and 99.

[2] From the earliest times men have appreciated the transcendent value of play in the development of childhood and youth. See, for instance, Plato, *Laws*, I, 643 and Rep. VII, 537; Aristotle, Bk. VII, 17; Froebel, *Education of Man*, § 30; Locke in Quick's *Locke on Education*, p. 55, 76.

A word may be said before leaving this subject upon specific sorts of exercise. Dancing is a very common form in our community; one hundred and sixty-seven of our students reported that they danced, while one hundred and forty-eight did not. The frequency with which dancing occurs differs much with different students; many of the young women in Ladies' Hall dance every night after the evening meal; others dance once a week or once in three weeks; while a few dance once a semester. The amount of dancing at any one time is, again, quite varied. In Ladies' Hall it lasts for an hour in the evening. Two students reported to have danced frequently until 5 o'clock in the morning; the majority of the others, however, ceased their pleasures at 11 or 12 o'clock at night. It is not necessary here to present arguments in favor of dancing as a beneficial form of exercise; from our point of view it answers well all the requirements, especially when it is taken under conditions of good ventilation and proper temperature. But too emphatic condemnation cannot be urged upon dancing until 12 o'clock at night once a week or once in two weeks or at longer or shorter intervals. This must be extreme for the average individual; and, like all kinds of excess, it must result in a positive detriment to the organism. While we have little data other than the testimony of experience for this statement, yet I think most people will agree that dancing for four hours produces fatigue, and that the individual is rather the worse for his recreation. If dancing be practiced as a form of business or of dissipation, that is one thing; if it is indulged in for recreation and recuperation, that is an altogether different thing. In order that recreation re-create it must refresh and not overtax; it must leave the individual with more of potency than he had when he started in, which cannot be the case when one dances four or five hours continuously. If we could only have dancing more frequently and for shorter periods, say twice a week lasting in no case beyond two hours, I believe it would be a valuable form of recreation; but it cannot be so considered as it is now practiced by many in our midst.

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[1] cf. the following: O'Shea, Physical Culture in the Public Schools: Atlantic Monthly, Feb., 1895; Groos: *Die Spiele der Menschen*, especially *Zweite Abtheilung*, pp. 467–503 and 516–526; Hughes: Educational Value of Play, and The Recent Play Movement in Germany; Ed. Rev., Vol. XIII, pp. 327 et seq; G. E. Johnson; op. cit., pp. 97 et seq.; Earl of Meath; Public Playgrounds for Children; 19th Cent. Vol. XXXIV, pp. 267 et seq.; Gulick: Psychological, Pedagogical, and Religious Aspects of Group Games; Ped. Sem., Vol. XI, No. 2; and Some Psychical Aspects of Muscular Exercises, Pop. Sci. Mo., Vol. 53, pp. 793–805.

Brain workers will probably be benefited more by activities requiring the greater use of the fundamental than of the peripheral muscles. Gymnastics and games then should not require too exact and delicate co-ordinations, since it would seem that student life really demands enough of this sort of thing in the prosecution of studies. The cerebral areas controlling the peripheral muscles are doubtless involved in thinking, and it is desirable that our recreation should relieve these areas from active exercise while calling others into play. Again, it seems to me especially desirable that our amusements should engage the muscles principally rather than the mind. Cards, checkers, authors, and the like must be poorly suited to the needs of those who use their heads constantly in their regular employments. Whist is a study; it probably dissipates as much energy as algebra, and utilizes somewhat similar parts of the brain. A student's life economically planned would aim to expend in study all of the energies which should be devoted to intellectual activities, while recreation would involve motor activities almost wholly. Billiards, for example, must be regarded as a very superior sort of recreation for a student, compared with euchre. Bowling is doubtless better still; and in short all pastimes in the gymnasium or out of doors that make the motor element prominent, are to be commended above those which are principally intellectual.

§3. *Sleep.*—In every living thing so far as we know periods of repose alternate with periods of activity. There is a kind of rhythm of action and of rest. Activity involves waste of living substance and cessation of action is essential that recuperation may take place. This rhythm is especially marked in human life. We have a long stretch, say sixteen hours, of waking life, during which mind and body are active and energy is dissipated; then there supervenes a season of quiet, when worn out tissue is repaired and the organism is brought back again to the normal condition. This period of rest seems to be even more important than nutrition for the preservation of life; for experiments have been made upon dogs showing that death followed more quickly from lack of sleep than from lack of food.[1]

Hodges' studies[2] demonstrating that in the case of animals cerebral cells were depleted of their contents after a day's activities and restored during the quiescent period of the night are suggestive respecting what in all probability takes place in principle in the human brain. Waking life robs brain cells of their substance; then during sleep, when the mind is in repose, the cells regain the energy which is essential for the sustenance of activity. If a man be denied sleep so that the drain upon nerve cells continues beyond a certain point, he will, of course, be thrown into a condition of fatigue, when intellect and emotions must suffer. It is then of vital consequence in student life that periods of activity and rest be so alternated as to keep the nervous organism in the best possible repair.

Now, it has not been determined by exact experiment, so far as I know, just how much sleep an individual needs. In all probability this differs with different people. There have been great historical personages, for instance, who have been able while guiding the destinies of nations to survive on a very limited amount of sleep. Every one knows of Napoleon's capacity in this direction. On the other hand, Gladstone is said to have required seven hours' sleep quite regularly throughout his public life. In our own country there is a president of a great university who is reported to get along with at most four hours of sleep, and on occasions he is able to do well on two hours. But for the majority of individuals it is probable that somewhere near eight hours is essential.[1] Cowles,[2] Beard,[3] Mills,[4] and other writers upon nervous exhaustion are quite insistent upon this amount for all people; and while it may certainly be impossible for one individual to survive on what another will thrive on, yet it is probable that a third of the day spent in sleep could not but be of advantage to every person and in no case could it be a detriment.

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[1] I have lost my authority for this statement, but I remember clearly the experiments and the outcome.

[2] Loc. cit.

The majority of our students give the required number of hours to sleep. Two hundred and thirteen reported that they devoted eight hours to this purpose; fifty-eight spend seven hours; thirty-four, nine hours; one, ten hours; four, six hours; while only two spend five hours. If their sleep be sound then our students should on the whole be well provided for in this respect. But in many cases people feel they are complying with all the requirements if they simply lie in bed. However, in order that sleep be fully reparative it ought to be peaceful and dreamless; otherwise the cerebral areas concerned in conscious mental life are active and energy is being dissipated. That one may secure this perfect rest his sleeping environment must be quite free from noise. Noise has a peculiar effect upon one asleep; even the slightest auditory stimulus seems to produce a waking reaction. It appears that there is in the human soul a sort of memory of earlier racial experiences where noise was a most significant affair; an animal that could not awaken instantly upon sounds of howling or cracking or crunching or breathing in his vicinity would have little chance of escaping from enemies lurking everywhere. And now, although man is quite safe in an environment of any amount of racket, yet he has not fully outgrown this old racial tendency to awareness in the presence of noise. It is instructive in this connection to observe a little child who in the earliest weeks trembles with fright at a loud noise, and cannot sleep except in an atmosphere of quiet.

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[1] cf. Kotelmann, *School Hygiene*, pp. 187 and 225–231.

[2] *op. cit.*

[3] *op. cit.*

[4] Mental Over-work and Premature Disease Among Public Men. Smithsonian Inst., Lower Lectures, No. IX.

The effect of noise upon a sleeping subject has been studied by Lombard and others,[1] and the results are conclusive in showing that even a slight disturbance causes a decrease in peripheral blood supply, indicating that the blood is flowing in increasing quantities toward the brain which tends to return to the waking state. The charts which follow show this phenomenon.

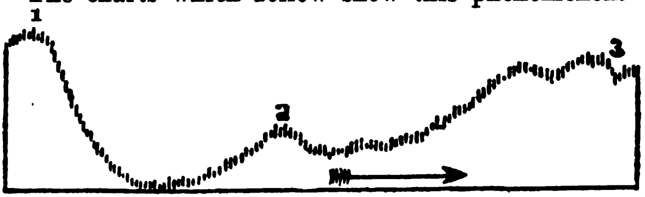

Fig. 11.—Plethysmographic record from the arm of a person sleeping in the laboratory. A fall in the curve indicates a decrease in the volume of the arm. The curve is to be read in the direction of the arrow. 1, the night watchman entering the laboratory; 2, the watchman spoke; 3, watchman went out. These changes occurred without waking the subject. (Donaldson, *op. cit.*, p. 289.)

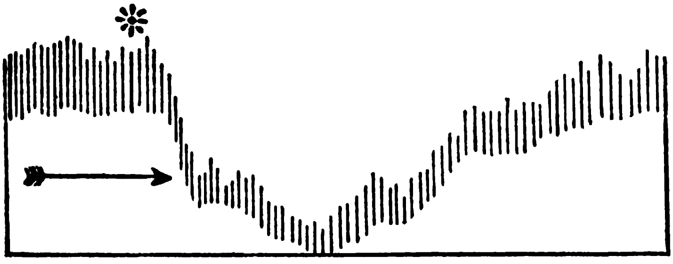

Fig. 12.—Record similar to that above. Change in the volume of the arm of sleeping subject, caused by the sound of a music box which was started at *. (Donaldson, *loc. cit.*)

The importance then of quiet while one is asleep cannot be too greatly emphasized. There should be a "rest" law in every house where students room, enacting that after a certain reasonable hour absolute quiet shall prevail. Certain it is, at any rate, that one whose sleep is not undisturbed will manifest the outcome in a lessened amount of vigor which may be utilized in intellectual work.

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[1] See for instance, Angell and Thompson, *op. cit.*, for a summary of results of investigations.

Some of our students preparing for examinations deprive themselves of sleep altogether for three or four nights. That this is a serious mistake hardly needs argument, it seems to me. It is probably not only a waste of energy in the long run, but really defeats the purpose for which the individual remains awake; for when the mind has been driven twenty-four hours without relaxation, it is not in a condition to do vigorous thinking; and if the strain be kept up throughout an entire examination week, the intellect must suffer in all its operations,—perception, memory, reason, and the rest. Some experiments have been made by Patrick[1] respecting the effect of prolonged absence of sleep upon muscular and intellectual capabilities, and these should be of interest to those students who study all night preparatory to an examination. The charts which follow indicate the increasing uncertainty in and diminution of various mental and physical powers as the period of constant waking life lengthens.

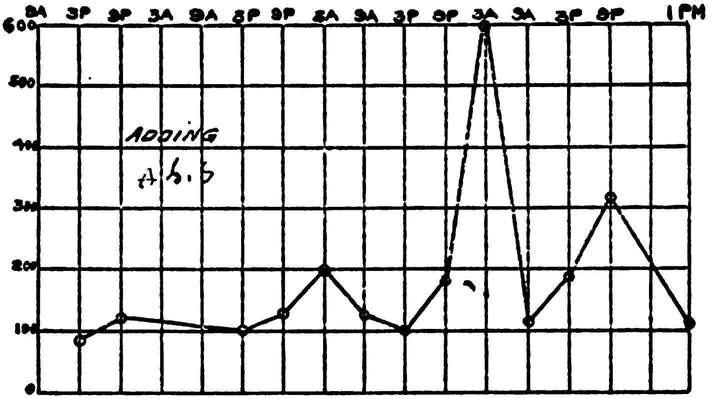

Fig. 13.—The ordinates show the number of seconds required to add a given number of figures. The abscissæ show the progress of the hours during the waking period. The last interval, however, representing the period of sleep following. (Patrick.)

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[1] At the University of Iowa. See Studies from the Psychological Laboratory of the University of Iowa, Vol. I.

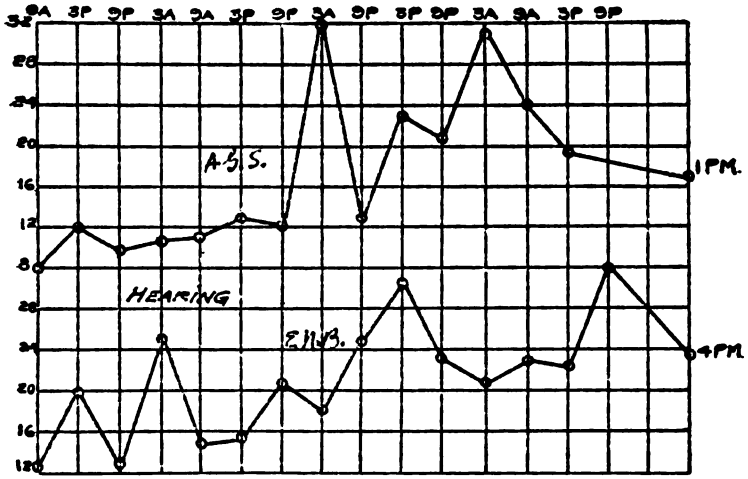

Fig. 14.—The ordinates show the relative intensities of sound required for discrimination. The abscissæ show the progress of the hour as explained above (Patrick.)

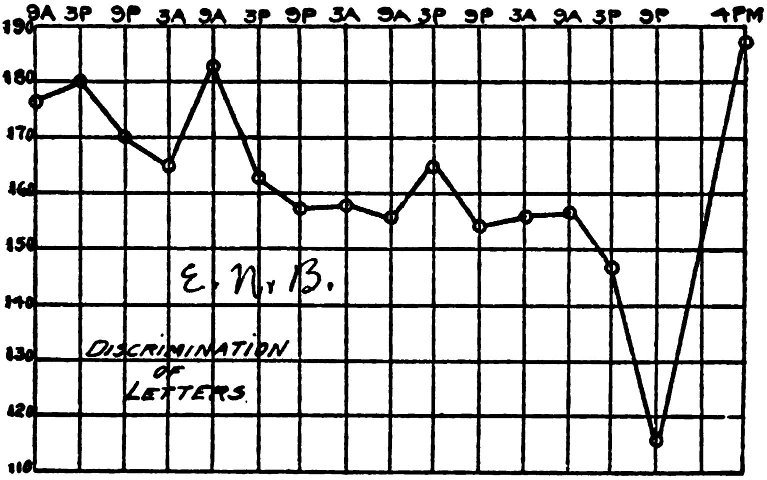

Fig. 15.—The ordinates show the number of letters named in one minute. The abscissæ show the progress of the hours as explained above. (Patrick.)

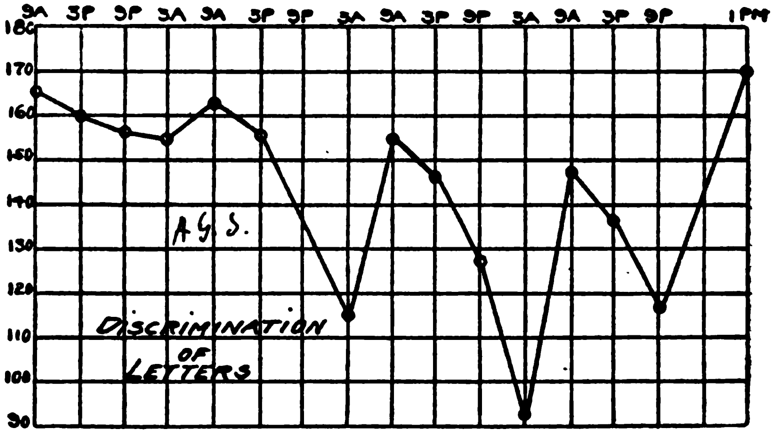

Fig. 16.—The ordinates show the number of letters named in one minute. The abscissae show the progress of the hours as explained above. (Patrick.)

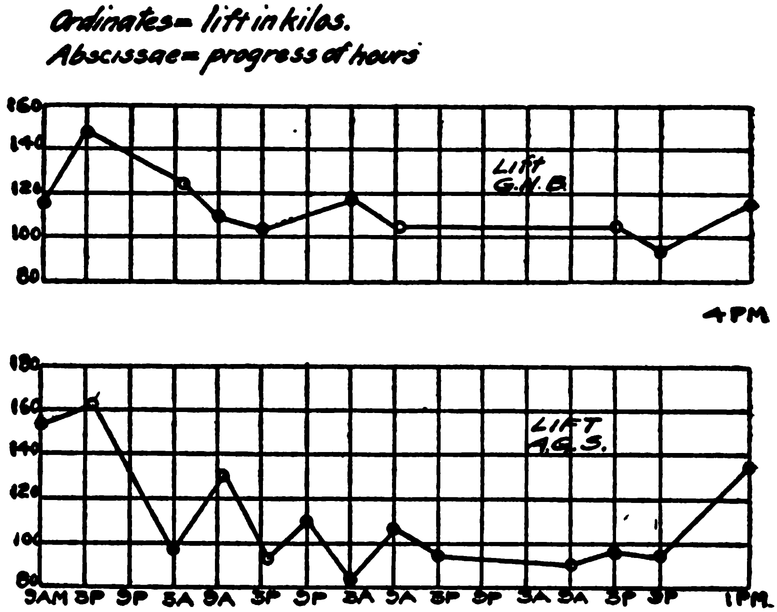

Fig. 15.—The ordinates show the strength of lift in kilograms. The abscissae show the progress of the hours as explained above. (Patrick.)

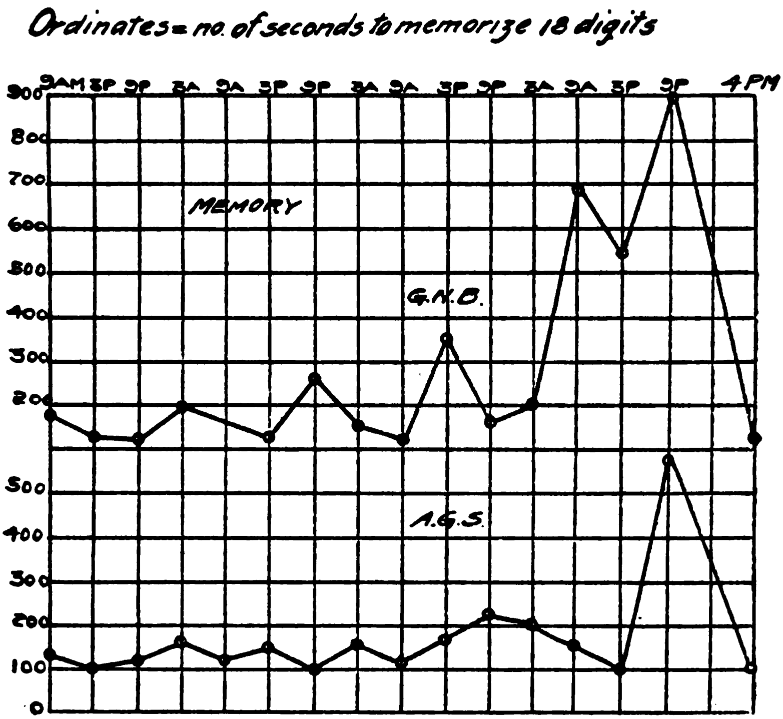

Fig. 16.—The ordinates show the number of seconds required to commit to memory 18 digits. The abscissae show the progress of the hours as explained above. (Patrick.)

It is probable, to add a last word, that a student who studies hard for say eight or ten hours has accomplished all that can be done with profit or with safety without a long period of sound sleep. Memory and reason will be more faithful and accurate the following day if the mind be thus refreshed than if it be driven on beyond the point of normal fatigue. And then when exhaustion is reached it requires such a relatively long time for recovery.[1] In normal fatigue a night's rest should bring complete restoration; but there is a point beyond this where the cell seems to lose the power of ready recuperation and it takes the spendthrift a long time to get back to himself, so to speak.

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[1] See Hodge, *op. cit.*

CHAPTER IX.

THE CONSERVATION OF ENERGY.

§1. *Wasteful Muscular Tensions.*—It is recognized in mechanics that a large part of the energy expended in the working of a machine is wasted; a relatively small amount, say 25%, in the best machines is devoted to accomplishing the purposes for which the machine exists. The more perfectly a machine can be constructed so as to save this fruitless expenditure of force the more efficient it becomes, of course; and so it is of vital consequence that friction and other avenues of waste be blocked up as fully as possible. Now the human organism is a sort of machine; it has work to accomplish and a given quota of energy which may be drawn upon for this purpose. It is a truism that the greater the amount wasted the less can be expended in profitable production. But if one should maintain that this body of ours has been so carefully fashioned that there can be no loss of vital force, that all parts run together so smoothly and co-ordinate so perfectly that every item of expense is in lieu of value received, he would doubtless have a show of reason on his side. It would certainly be a fortunate arrangement if this most intricate of all mechanisms could run of itself without superintending and with no loss or unnecessary outlay of vital force; but I think we shall see that with the majority of us there are frictions which can be at least reduced by a little deliberate planning.

The greatest source of waste of neural energy is found in muscular tensions which are not at all essential to the accomplishment of the piece of work in hand. This is seen to be true in view of a simple physiological law,—that the exercise of a muscle involves stimulation from nerve centers. This stimulation implies a drain upon nerve cells,—an expenditure of energy, that is to say. When any task, as writing, is to be undertaken, then economy demands that no muscles be active except such as contribute to the accomplishment of the work. But suppose that the hand not employed is clinched, the lips are compressed, deep furrows crease the forehead, and the fingers controlling the writing are unduly tense,—in such a case a large amount of effort is proving fruitless. The unnecessary constraints of muscles are simply draining the organism of energy that should be conserved and expended in profitable directions.

Now, there are certain practices in student life, as in the lives of people in general, which entail waste of vital forces and which can be modified without inducing too great self-consciousness. In the first place mental tension readily begets muscular tension. When the mind is perplexed; when it discerns obstacles ahead that seem insuperable; when conscience is incessantly active censuring one for past deeds and exhorting him to be especially careful in the future; when life seems full of cares that demand unceasing attention,—such a condition of mind produces constraints of muscles which sap the organism of its vitalities. When the attention is centered upon threatening difficulties the body unconsciously takes on an attitude of defense, as it were; or, to be more precise, the organism seeks to adapt itself to a mental situation and when we are troubled in mind our muscles get ready to annihilate the causer of our trouble, or to remove us therefrom.[1] One may see on our campus every day students with set faces, so to speak; there are deep lines between the eyes, there is a strain about the mouth, and the entire body shows rigidity and tension. When you talk with such students you can observe these abnormal "nerve-signs" in all the sensitive muscles of face, hands, and body generally. Such people are what might not inappropriately be called exhaustives; they are all the time drawing upon their bank deposits too heavily. Outlay commonly exceeds income, or at least there is no large balance on the credit side of the account. These are the over-conscientious individuals; they can never do anything without worrying about it before and afterwards; they are troubled lest they have not done or will not do just the right thing. They belong to what Ribot would call the egoistic-introspective type; they cannot get away from themselves, and hence are constrained and tense in most of their activities. It seems to be a law of our human nature that turning the mind upon self throws the machinery out of gear. Too much reviewing of conscience; too much hunting after one's faults ends in conscience being a very ineffective guide in life. Its mandates cannot be carried into effect by a weakened organism.

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[1] Cf. Angell and Thompson, Psychological Review, Jan., 1899, p. 69. See also Darwin: *Expression of the Emotions in Man and Animals* for a discussion of the general principle involved. Baldwin: *Mental Development, Methods and Processes*, Chap. VIII, treats of the subject in a readable way.

So much has been said in recent years about "Americanitis" that it may just be mentioned in this connection. It is maintained that our American people do not know how to rest; which means, I think, that they make a great deal more fuss about doing a thing than is necessary. Their actions are greatly in excess of that which the occasion demands. When they do things that should employ the hands only, they use the whole body; they scowl and grit their teeth, and in other ways drain off their forces. Dr. Clouston, the eminent Scotch authority upon nervous diseases, visited our country some time ago and is reported by James[1] to have said: "You Americans wear too much expression upon your faces. You are living like an army with all its reserves engaged in action. The duller countenances of the British population betoken a better scheme of life. They suggest stores of reserved nervous force to fall back upon, if any occasion should arise that requires it. This excitability, this presence at all times of power not used, I regard as the greatest safeguard of our English people. The other thing in you gives me a sense of insecurity, and you ought somehow to tone yourselves down. You really do carry too much expression, you take too intensely the trivial moments of life."

It is a vitally important matter in student life to acquire the habit of adjusting effort to the task to be accomplished. When great tasks are to be performed our forces must all be summoned to the fore; but it is certainly bad economy to expend as much on trifling as on momentous occasions. But how can we release these wasteful tensions? Manifestly the first requisite is to alleviate the mental attitude which produces them. To many it may seem heretical, but yet it seems to me true that there is too much examination of conscience, too much thinking about self in our American life. One who keeps his errors constantly before his mind's eye pursues the very best course for dissipating his forces. One cannot be looking all the time upon his own shortcomings without strain and stress of mind and body in the effort to overcome them. And, unfortunately, the more he thinks of them the more securely do they fasten themselves upon him. He rises above his lower self mainly by filling his mind with ideals outside of himself, so that he may grow up toward them. This is the only way, too, in which the machinery of life can be got to run smoothly; which fact is evidenced constantly among the people we meet in daily life. You see here a person who lives an outward life. She thinks little relatively of self, does not question unendingly whether what she does is just right and proper, whether she ought not to have done something else, whether other people's actions are intended to injure her. Her mind is full of worthy generous ends to be attained. Then observe her physical expressions: no scowling except when there is occasion for it; no rigidity of features, no constraint and formality of bearing. Rather she is free and unconstrained in all her activities; the delicate mechanisms of her being work together harmoniously and energy is expended only when work is to be accomplished. Much egoistic-introspective thinking seems to irritate the nervous system, unloosing forces which should be securely held until their services can be profitably utilized.[1]

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[1] Scribner's Magazine, April, 1899, p. 502.

While bodily relaxation is secured primarily through mental poise, still something may be accomplished by voluntarily striving to let go of one's self. There is a good bit of sense in the Delsartean philosophy,[1] which holds, first, that the most vigorous individuals in intellect and character are those who are freest and most unconstrained in peripheral activities; and, second, that by proper exercises we may cultivate the power of "holding centers firm and releasing extremities." The Delsartean physical culture really helps "bottled lightning" people to take themselves less seriously. There are so many persons who, even when they rest, as they say, sit with clinched fists and rigid body, thus keeping up incessant drain on the nervous system. Let one who is conscious of tenseness in his muscles voluntarily relax at certain times of the day as a matter of discipline. This will assist in relieving the brain, and in time he will find himself relaxing unconsciously. He will find, too, that his mental briar-patch will not seem quite so thorny; he will occupy a less prominent place in his own reflections: for as mind influences body, so body influences mind.[2] Voluntarily assume an attitude and it will tend to awaken the emotion which usually initiates that attitude. Take on the bodily counterparts of fear and fear is easily engendered; while, if you stand bravely against the world, courage will be strengthened. So one who consciously puts himself into postures of rest and repose will go a good way toward securing mental quietude. As when the mind is worried it keeps the body aroused to ward off threatened dangers, or to accomplish visionary tasks; so let the body take an attitude of repose which is bred of confidence and trust that all is well with the world, and the mind will easily follow in its lead.

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[1] We are coming to see that too great self-consciousness is a disease breeder. Faith cure, divine healing, and all the rest accomplish their good work by getting the mind of an individual off from himself. The literature of the subject is very extensive; but for an interesting study and resumé of important investigations, see Goddard: The Effects of Mind on Body as Evidenced by Faith Cures; *American Journal of Psychology*, April, 1899.

Wasteful muscular tensions are begotten by other agencies than a restless, worried, over-scrupulous mind. The implements we employ in our daily tasks are responsible for much useless drain upon the nervous system,—such apparently simple and harmless things as writing pens, pencils, and the like. To appreciate the principle here involved one needs to recall what has been said respecting the hierarchal character of the cerebral mechanism. It is needful to remember especially that the "highest" brain centers exercise a general control over more fundamental ones and are charged with the management of the peripheral muscular activities. Now, it seems to be true, although it has not yet been so proven by extensive experimentation that co-ordination of the peripheral muscles involves a relatively larger expenditure of energy than coarser, less delicately adjusted movements. Thus fine needle-work is more fatiguing to most women than washing dishes, and "getting pigs out of clover" is a much greater strain on any man than playing golf or croquet. It is a rational inference, it seems to me, from the known methods of cerebral action that in the majority of people much activity of the third-level cerebral areas, those governing peripheral muscles, results in the setting free of a larger quantum of energy than is required to perform the work in hand. Peripheral muscles as they are found in the human organism have appeared relatively late in the development of the race, and the nerve centers controlling them are not yet seemingly, for most people, quite stable. Paths for the discharge of nerve force have not become deeply grooved so that much overflows into by-channels, as it were. On the other hand the fundamental bodily actions have become so habitual that they do not apparently lead to waste; the neural avenues controlling them have become so fully established that energy generated issues in profitable production for the most part.

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[1] For an interesting presentation of this philosophy, see Annie Payson Call: *Power through Repose;* and Emily Bishop: *Americanized Delsarte.* See also O'Shea: *Physical Training in the Public Schools,* loc. cit.

[2] cf. Lee and Thomson: Beauty and Ugliness; Contempt. Rev. vol. 72; James: *Psychology, Briefer Course,* p. 383. Baldwin, *op. cit.,* p. 231, *et. seq.*

The position here taken is by no means fully warranted by experimental evidence, and there are those scientists who feel that through habit the individual may get to be as economical in the use of peripheral as of fundamental muscles. My own observations, however, lead me to believe that in the majority of cases these conserving habits never become established in most of us. I was able several years ago to gain something relating to this point from the experience of a distinguished physician in Buffalo, a specialist in diseases of the nose and throat. Some of his work involved very delicate operations requiring most accurate co-ordinations of the fingers. He said to me frequently that he never undertook such cases except in the morning hours when he was at his best; and after a relatively short period he generally was greatly fatigued, so that he felt it necessary to secure rest before continuing with his duties. On the other hand, a half day's work in his general practice which did not involve such exact co-ordinations would not overtax him. In my own case, writing with a fine pen, which must be handled tenderly in order to avoid catastrophes, soon exhausts my store of energy and of patience; and I found during the past year, while experimenting with writing pens, that an assistant and a member of my own family had experiences similar to my own.

This phenomenon is especially apparent in the case of younger people. Put a child of eight or nine to writing with a fine pointed pen and in a short time you will observe tensions in various parts of the body not employed in the writing. Soon the tongue will be extended, the hand not engaged will become clinched, the head will begin to keep time with the arm; the whole showing plainly to my mind that the co-ordinations demanded in the writing have liberated energy which is escaping into channels which should have been closed up. On the other hand, permit such a pupil to write with chalk at the blackboard and he will continue for hours without apparent over-strain. One who has opportunity to study developing children in the home will be impressed with this wastefulness of too co-ordinated activities.[1] It is recognized, of course, that with the development of the nervous organism greater delicacy and complexity of co-ordinations are possible with less of waste; but yet I believe that at no time does the average individual reach a point where he can economically practice the most exact adjustments where coarser ones would answer just as well.[2]

This leads to a few practical suggestions respecting some of the implements which are used extensively in student life. And first the writing pen. Many of our students write a great deal some reporting six hours of written work a day. But this is extreme; the average is about two and one-half hours daily. Ninety-nine reported using fine pointed pens, while sixty-seven used medium pens, and one hundred and eleven used blunt points. It would be interesting to know whether those students who employ fine pens and do much writing are able to prosecute their work without fatigue; but in lieu of data upon the subject, the opinion may be hazarded that a medium or coarse pointed pen would be the means of conserving energy for the great majority of students, not excepting those who have formed the habit of using a very fine point. To repeat, though, this subject needs more extensive investigation before one may dogmatize upon it.

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[1] See O'Shea: When Character Is Formed, Popular Science Monthly, Sept., 1899.

[2] Cf. Hancock: A Study of Motor Ability; Ped. Sem., Vol. 3, pp. 9-29.

Believing that the matter of writing pens is a most important one for students, I have during the past two years made a test of all the pens I could secure from American manufacturers with a view to ascertaining their energetic effects upon myself and my assistant. While doubtless I have not had opportunity to examine all the good pens made, I yet feel that of those commonly in use the one of medium point requiring the least waste of energy in needless tensions is the Gillott No. 1065. It has been my experience, however, that the ordinary gold pens are far more satisfactory than those made of steel, since the point moves over the paper more smoothly, requiring less delicate management from the penman. I have been able to examine a number of fountain pens and have found the Waterman Ideal worthy of its name. Nos. 12 to 16, medium points, are well adapted to conserve the energies of the penman, as well as to gain time in writing, and they can not be too highly commended. I have also found the Parker Jointless No. 023 to be a very satisfactory pen from the point of view from which we are here discussing pens. I can write much longer and with less fatigue with these fountain pens than with any steel pen, and those who have assisted me in the experiments have had a similar experience.

"Scratchy" pens cannot be too severely condemned. Aside from their irritating influence upon the nervous system, they require such careful handling that waste of energy cannot be obviated. I have never known a person to write long with such an implement without manifesting fatigue in body and mind. Students who employ such articles to save expense or time in securing something better belong to the penny-wise and pound-foolish fraternity.

Another most important characteristic in a writing pen is the material of which the tip or holder is made. Metal holders are very common, although fortunately only about six per cent. of our students employ them; the others use either rubber or wood holders, or fountain pens. It may perhaps be worth saying for the benefit of the benighted six per cent. that they have adopted a most efficient plan for wasting their vitalities. When the fingers grasp a metal surface perspiration accumulates quickly, and if it be round it will tend to roll in the fingers. In order to keep it in proper position there must be increasing tension which, as any one may by trial prove to his own satisfaction, is a potent agency in dissipating energy. Let one who uses such a pen-holder exchange it for another with a cork tip, where the moisture from the fingers is readily absorbed, and he will find that too great emphasis has not been laid upon this apparently trivial matter. The principle involved applies as well to lead pencils; those with highly glazed surfaces are difficult to keep steadily in the right position without undue constraint of the fingers. The Eagle Pencil Company is now manufacturing a pencil answering the requirements in this regard. The Eagle Cortex No. 2 has a surface of cork, and I have never known a person to try it without commending it because of the ease with which it may be managed. It may be criticised in one respect only, that the lead is a trifle too hard for the greatest economy in nerve force.[1] A hard lead pencil, like a fine pointed pen, demands relatively great co-ordinations and tensions in its control, and hence leads to waste of force.

Three years ago a change was made from hard to soft lead pencils in the Franklin School, in Buffalo, and the children were unanimous in their praise of the softer variety. "They are so much pleasanter to use" was the general testimony. I have examined most of the pencils of American manufacturers, I believe, and have found the Eagle Draughting to be the most satisfactory. Our students are not so wise in their choice of pencils as of pens. About seventeen per cent. of those reporting use hard pencils, while thirty-two per cent. use a medium quality. The engineers use a hard pencil almost altogether, and this is doubtless necessitated by the character of their work.

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[1] As this is passing through the press the Eagle Pencil Company sends me a pencil with cork covering and soft lead, which meets the requirements indicated herein.

Needless muscular stimulations wherever they occur must be regarded as dissipating vital forces. Thievery of the most serious kind is constantly taking place. This is especially significant in respect of the eyes. One who has reflected upon it can not but be impressed with the marvellous delicacy required in the proper control of the visual organs. During waking life they are incessantly changing position so as to bring objects within the range of vision. In order to accomplish this they must be equipped with ocular muscles[1] so arranged as to secure movements in all directions within a given orbit.[2] In the normal eye these muscles are exactly balanced in their pulling capacities and are never active except when the interests of vision require action. But now it happens in frequent instances, so frequent as to be alarming in these last few years when investigations have been made so extensively, that one of the muscles moving an eye may be more energetic than its fellows. Or through some error in the functioning of the reflex nervous mechanism it may be active when it ought to be at rest. It tends then to pull the eye out of focus, which would render vision double if it had its way; but the will seeks to avert this calamity and so must stimulate a muscle opposed to the overacting one so as to neutralize its effect. This results then in incessant muscular strain which is a source of constant waste of vital forces.

Again, in the normal eye the lens and eye-ball are so constructed that the focus falls exactly upon the retina. But now it occurs more frequently than not it seems that this fine adjustment is not secured. The lens has not the right degree of curvature as a whole, or in certain angles, or the eye-ball is either too short or too long, when the focus falls in front of or behind the retina, or is not the same at every angle. The mind tries to remedy any error of this sort by modifying the lens through the delicate ciliary muscles. In a defective eye this stimulation must go on incessantly, and one can easily imagine its effect in draining the organism of its vitality. Every one has heard in these recent years that the eye is the source of all disease; and while this is doubtless an exaggeration, it yet emphasizes a certain truth of vital importance to every individual, but especially to the student in whom defective vision entails most serious consequences, alike in blocking one important approach to the mind and in robbing the system of its energy.[1] In the defective eye these muscular tensions go on hour after hour, and only the most hardy constitution can endure the strain. This is evidenced in a striking way in the sudden increase in eye defects during adolescence. A great many boys and girls realize that they have eyes at this time.[2] The organism is now devoting its strength to the building of heart and lungs and bones and cannot expend so much in disciplining refractory eyes, when their baneful effects become apparent. So, too, in sickness people are conscious of eye strain that they have not noticed before and which they are never really conscious of except when the energies of the organism are at a low ebb. Swift[3] observed this phenomenon frequently in his study of vision in the Normal School at Stevens Point, Wis. He says:

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[1] The four recti and the two oblique muscles.

[2] See Le Conte, *Sight*, Chapters 2 and 3, for a good discussion of the muscular mechanism of the eye and the philosophy of defects. See also Cohn, *Hygiene of the Eye*, Chapters 1–8.

> "An interesting fact, though by no means a new one, was repeatedly observed. Young boys and girls with more defect than some older ones had never experienced any trouble with their eyes, while the older ones, with much less defect, were constantly annoyed by eye ache or the blurring of the letters. The difference was that the vigorous nervous system of the young boys and girls was able to sustain the irritation of the poorly constructed eye and, by an over supply of nerve force, could

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[1] See for an excellent discussion of this subject: James, *Suggestions to Teachers Regarding Visual Defects of School Children*, Mankato, Minn. Also Ranney, in New York Medical Journal, June 11, 1892.

[2] See, *Some Adolescence Reminiscences*, O'Shea, Journal of Pedagogy, Oct., 1898.

[3] Pedagogical Seminary, October, 1897, and reprint.

compel the eye to do its work without apparent injury, while the more exhausted nerve centers of the young men and women could not stand the constant call for more energy. 'Disease is localized abnormal innervation and always central in the nervous system, being a lack of excess of motive force.' It should not be forgotten, however, that eye strain is a potent factor in this disturbance of the nerve centers."

One observing students on the campus of our University is impressed with the number who are not spectacled. Whatever opinion he may hold regarding the relation of spectacles to mental attainment he must at least conclude that many students are wasting energy in combating visual defects that ought to be remedied by glasses. Investigations made within the last decade in various parts of our own country and Europe[1] show that on the average at least 30 per cent. of individuals have defects of vision which require correction by lenses. And the defects increase with age; as high as 40 or 50 per cent. of the children in the upper grades in some places have defective sight. According to Sherzer:[2]

> "An examination of the eyes of over 5,000 school children and students in Germany, France, Russia, England, and the United States, has shown that as we pass from the lower to the higher grades there is a gradual increase in the number of cases of myopia and in the degree of the defect. The German government in a recent examination found that in the elementary schools from 5 to 11 per cent. of the children are afflicted; in the higher schools for girls, 10 to 24 per cent.; in the Real Schulen from 20 to 40 per cent.; in the Gymnasia from 30 to 50 per cent.; while in the universities the percentage may run up to 88."

According to Cohn[3] myopia increases rapidly with age in the German schools; "in the real schools the myopia percentages from the sexta to the prima were 9, 16.7, 19.2, 25.1, 26.4, 44; in the gymnasia 12.5, 18.2, 23.7, 31, 41.3, 55.8." Professor Swift's[4] researches seem to indicate that nearly every student examined had some visual defect. Investigations in the schools of Sioux City, Iowa, show something like 50 per cent. of defectives in the highest grades. In Rochester, New York, 31 per cent. of the children in the high schools have defects of vision which could be detected without any expert examination. And so it goes. Prentice,[1] Cohn,[2] and others have recently shown beyond a doubt that no individual can afford to go through life without ascertaining the condition of his eyes; and yet 40 per cent. of our students report that they have never had their eyes examined. It would indeed be a remarkable circumstance if there was not stealthy thievery of nervous energy taking place constantly in a number of these cases.

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[1] See Cohn, *op. cit.*, Chapters VIII and IX, for many tables presenting the results of examinations in various countries.

[2] *Rules for the Care of the Eyes;* published by Michigan State Normal School.

[3] *Op. cit.*, p. 57.

[4] *Loc. cit.*

Because one is not conscious of a defect is not conclusive evidence that he does not possess it. I take my vision to be the standard, the normal, unless somebody has shown me better. If I am born with a myopic eye and can scarcely see my hand in front of me, I have no way of telling that I am not as other people are. The only safe course is to have my vision measured up to a norm or standard; and if it does not fulfill requirements to call to my aid the skill of the oculist and of the optician.

For the most part the eye has been used throughout racial history in discerning relatively large objects and those at a distance. It has been only within the most recent period that such visual co-ordinations have been required as are necessitated in our day in the reading of print. Authorities agree that a child of five or six, for instance, has not developed the visual capacities to read ordinary print with safety.[3] When a child of this age is set to studying a primer, printed in the type that such books usually are, or at least have been in the past, he not only suffers great strain, but injury is apt to result to the visual organ. Now it is probable that even in adult life the reading of fine print requires co-ordinations of ocular muscles which result in dissipation of nervous force. Cohn,[1] Sanford,[2] and others have calculated the size and shape of letters which can be read with greatest ease. Burnham[3] summarizes the results of investigations upon this subject in an excellent way and his words may be quoted:

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[1] *The Eye in Its Relation to Health.*

[2] *Op. cit.*

[3] See, for instance, Oppenheim, *The Development of the Child,* Chapter V; also Dewey, The Fetisch of Primary Education, Forum, May, 1898. Indians are said to have difficulty in accommodating their vision to print.

"1. *Size of the Letters.* It is necessary that type be easily legible at a distance of twenty inches. For this it is necessary, according to Dr. Cohn's estimate, that the letters be 1.5 mm. high. 'Any type that is smaller than 1.5 mm. is injurious to the eyes.' An angle of five minutes is sufficient for the recognition of a letter; hence, according to the estimate of Dr. Weber, a healthy eye can read clearly a letter .7 mm. in height without extreme convergence; but such reading is very laborious. Weber tested the time occupied in reading with different types. When the size of the letters was greater than 2 mm., he found that the speed of reading was retarded. He decided for a minimum of 1.5 mm. Eulenberg and Bach demand still larger type for the lower classes. Many of the school books in common use have much smaller letters than Weber's minimum. In some of the school atlases, letters only .5 mm. in height are used. Many very beautiful maps also have very small type. Especially before pupils have become familiar with the letters, it is necessary to have large type. Javal wishes to have it determined by experiment how large the type should be in the different classes in order that no pupil, however bad the light, need bring his eyes too near the book.

"2. *The Thickness of the Letters.* 'No print of which the down stroke is thinner than 0.25 mm. should be tolerated in school books.' In Latin type the corners of the letters should be strengthened in order to make them appear rectangular, otherwise by the irradiation of the white ground they appear rounded off.

"3. *The Shape of the Letters.* Javal points out that, if the lower half of a series of words be hidden from view, it still is easy to read them. But when the upper half is covered, it is difficult, often impossible, to do so. In reading, we glance along the line at a little distance above the center of the letters; and the letters g, j, p, q and y are the only ones that come below the line. Thus the upper part of the letters are of special importance. As the result of an extended research, Dr. Sanford found several groups of letters in our alphabet that are relatively poor. Of the small letters c, e, o are confusable with one another; a, n and u are poor letters; and s, i, l, t are liable to cause confusion. Javal, Cat-tell, and Sanford have each suggested changes for improving the form of some of the worst letters. Among the most important of these are Javal's suggestion that letters be made broader, and that we return to the more open forms of c, e, and o, and Sanford's suggestion that a letter in shape of an inverted v or of a small cap ᴀ might be substituted for our present small a.

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[1] *Op. cit.*, Chap. XXIII.

[2] The Relative Legibility of the Small Letters, Am. Jour. of Psychology, Vol. I, pp. 402–435.

[3] *Op. cit.*, pp. 49–51.

"4. *The Approach.* The distance between letters and words, or the approach, is important. Every letter stands out with especial distinctness when the space between two letters is wider than the space between the ground strokes of the letter. For this reason words are emphasized in German by spacing the type. This greater approach adds to legibility. School-books should have an approach of nearly 1 mm.

"5. *'Leading' Is Important.* 'A book has good interlineage,' according to Dr. Cohn, 'when, if the letters are 1.5 mm. high, the lines are 3 mm. apart.' A distance of 2.5 mm. (1–10 of an inch) is the smallest admissible. Many of the old books had wider interlineage than is usual at present.

"6. *The Length of the Lines.* The shorter the line the more easily can one read. Javal thinks the long lines the cause of progressive myopia in Germany. According to Dr. Cohn, the greatest length of line should be only 10 cm. Weber would have lines from 14 to 15 cm. in length.

"Dr. Cohn resumes his rules as follows: 'In the future I would have all school authorities, with measuring rule in hand, place upon the *Index librorum prohibitorum* all school-books which do not conform to the following measurements: The height of the smallest "n" must be at least 1.5 mm. (.06 inches), the least width between the lines must be 2.5 mm. (.1 inches), the least thickness of the "n" must be .25 mm. (.01 inches), the shortest distance between the letters .75 mm. (.03 inches), the greatest length of text-line 100 mm. (4 inches), and the number of letters on a line must not exceed 60.' "

It is of course difficult for a student to alter the type of his text or reference books, and attention is directed to the matter here chiefly in the hope that those who have the choosing of such books may take this energeic question into consideration. It is of especial significance perhaps to students in the languages who have occasion to consult dictionaries freely.

Attention has been directed thus far to the waste entailed by needless tensions resulting from a worryful mind, from the use of implements requiring unnecessary co-ordinations, from defective vision, and from too concentrated employment of the eyes. Before leaving this general topic, a word should be said regarding another factor in the causation of wasteful tensions. The human body in a standing or sitting position is, as everybody knows, acted upon by gravity, and if it be thrown out of plumb, so to speak, it tends to fall to the earth. This catastrophe can be averted only by the action of muscles which pull against gravity, and so serve to keep the body in equilibrium. Suppose now a person on foot or in his seat in such a posture for some time that gravity has a leverage on him, and his muscles are doing their best to prevent his falling; it is easy to see what this means in terms of nerve force. It involves nothing less consequential than a ceaseless drain upon the system. People who do not habitually stand or sit in such manner that the body is poised, as it were, and at rest will certainly suffer for their error in lessened efficiency in both physical and mental work.

This principle is of special value to a student as it relates to the position he habitually takes while engaged in study. In order that this position may comply with the requirements of economy in the expenditure of nervous energy, the study desk and chair must be exactly adjusted to the bodily measurements of the individual so that while using them there may be little occasion for muscular strain. No statistics have been gained regarding local conditions in respect of this matter, since in order to be of value they would require considerable exact measurement and this we could probably not have secured; but it is not unreasonable to suppose that students have not accidentally and in all cases hit upon the proper regulations respecting the height of desk and chair and their "distance" relations to each other. Now, recent investigation has established something like a law of hygienic seating Lincoln,[1] Barnard,[2] Marble,[3] and others in our own country and many scientists abroad[4] have given much attention to this subject during the past few years, alike in the study of the physiological conditions which should govern seating and in the detailed measurements of many thousands of individuals of different ages to ascertain in a general way the requirements for persons of different ages. Meyer's statement[1] of principles is as follows:

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[1] *The Sanitary Conditions and Neccessities of School-houses and School Life.*
[2] *School Architecture*, New York, 1860.
[3] *Sanitary Conditions for School-houses.*
[4] See The Pedagogical Seminary, June, 1892, for a summary of investigations.

> "The two seat-bones are curved like a bow; a line joining the lowest points of these two bones is called the seat-bones line; the center of gravity of the body is in front of the ninth or tenth chest vertebra; and a straight line from this point to the ground is the line of gravity. Upright sitting is possible only when this line passes through the seat-bones line. This line determines the surface of support for the body. But the least movement that displaces the center of gravity makes upright sitting impossible without great muscular effort. The surface of support is then determined by some third point. In a forward-sitting posture the line of gravity falls in front of the seat-bones line, and the third point that determines the surface of support is given by the edge of the form, or when the seat is not broad, by the point where the feet come in contact with the floor, or by both points together. The line of gravity may now fall on that surface which is determined by the front edge of the seat and by the muscular effort required to keep the body in equilibrium. Hence the nearer to the knee the seat extends, the larger the surface of support and the easier it is to retain the equilibrium. All the demands for an upright sitting posture would now be satisfied if the trunk were immovably fixed in the hip-joint, but it is joined movably to the thighs; hence the upright posture can be maintained only by the work of the pelvic muscles. The muscles soon become fatigued and the body would fall forward unless supported by leaning the chest and arms against the table.
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> In the backward-sitting posture, in which the line of gravity falls back of the seat-bones line, the end of the coccyx is the third point which determines the surface of support. This position has the great advantage of having this third point fixed and immovable. The body with this backward inclination should be supported by a back rest. This may be placed against the shoulders, but then the position is a half-reclining one. The lower down it is placed within certain limits the more it helps in an unright posture. Placed at the upper edge of the hip-bone, or back of the last vertebra, it holds the pelvis and the trunk in an upright posture. The principle then is as follows: A pupil must always take those positions in sitting in which the line of gravity falls a little back of the seat-bones line. The upper part of the body also must be supported. It is easy to determine the kind of seat that should be used in accordance with this principle."

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[1] Summarized by Burnham, *op. cit.*, p. 40.

All that can be attempted here in this discussion of seating is to direct the attention of the student to the importance of the matter in the hope that he will try to arrange his chair and desk so as to save nervous wear and tear to the fullest possible extent. One suggestion may be made, however, that there should be a back-rest to the chair, and it should support the back under the shoulders and above the hip-bones. In Saxony there is a state-regulation to the effect that school seats must be provided with shoulder rests and cross back-seats. The distance of the chair from the edge of the desk should be such that the student while sitting erect can place the fore-arms on his desk without stooping or without elevating the shoulders. In order to meet this requirement the top of the desk should overlap the seat by two or three inches—there must be a "minus" distance, in technical phraseology. This is rarely found, in my experience, in students' rooms, for the reason that it involves some bother getting free from the desk; but the greater comfort thus ensured, and the energy conserved would more than outweigh the slight trouble which such an arrangement would occasion.

The matter of seating is of consequence not simply from the point of view of saving energy, but it has an important influence also upon the generation of force. A student leaning over his desk, with his lungs constricted and the arteries leading to the head compressed, is in a good way to foster mind wandering and napping. The organism then becomes clogged, as it were; it does not receive its due of oxygen, as a result of which the brain must certainly become seriously handicapped.

§2. *The Daily Program.*—During the past decade a great deal has been said, alike in the educational and in the secular press, regarding over-pressure in education. Physicians and educators have noted with great apprehension the apparently increasing number of pupils in the higher schools who are deficient in that vigor and robustness of body and mind which are essential for success in the battle of life. We are told that nervous diseases are much more frequent in youth today than they were a generation ago, and the fault must lie with the schools; they pass the safety line in the demands they make upon their pupils. This feeling has been so marked and wide-spread that investigations have been prosecuted in Europe, and to some extent in our own country, to ascertain the true condition of affairs respecting the amount of work required of students. Thus far little of definite scientific value has been attained; but yet the conviction is deepening in the public mind that education is too much of a forcing process which calls upon energies that should be utilized in the growth of vital organs. Physicians have been urgent in their demands that the work of the schools be lightened. Oppenheim[1] is unsparing in his criticism of the present regime as it exists in the lower grades. Keating,[2] after long experience with diseases of children, finds that many of them have their origin in excessive strain incident to school work, and he too insists upon reform. Examinations of the school children of Germany have shown that in some instances they return to their work day after day with constantly increasing fatigue;[3] recuperation cannot take place fully during periods of release from recitation and study. While, so far as I am aware, no researches of just this character have been made upon fatigue in university life, yet many persons of good judgment are confirmed in the belief that even here students are overworked, and suffer in consequence thereof in some such way as do overtaxed children in the lower schools.

Some effort has been made to determine the amount of study which may be safely undertaken by a student at different stages in his progress through the schools. It must be apparent, however, that it is impossible to formulate any general law respecting this matter. Individuals differ so greatly in the amount of energy which may be expended in intellectual and physical activity that no rule could apply to all. Again, the kind of work done and the conditions under which it is prosecuted must exercise an important influence upon the readiness with which energy is expended. Some investigators are of the opinion, though, even regarding these varying and modifying factors, that university students on the whole cannot undertake with safety more than eight hours a day of difficult intellectual labor.[1] It is important to note, however, that during these eight hours the attention is to be concentrated upon mental tasks; mind wandering and reverie are not to be considered as work. If we compare the stint of our students with this as a sort of standard we find that some work too much, while others do not tax their energies to a legitimate extent. One student reports one hour spent in study; four, two hours; twelve, three hours; thirty-four, four hours; fifty, five hours; seventy-two, six hours; thirty-nine, eight hours; eleven, nine hours; thirteen, ten hours; four, eleven hours; one, fourteen hours. It is probable that the students reporting one or two hours devoted to study did not take into account time spent in the laboratories, so that their estimate is of no value to us here. About all that can be said is that students working ten, eleven, and fourteen hours a day are likely to draw too heavily upon their resources.

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[1] *Op. cit.*, Chapter V.

[2] *Mother and Child*, pp. 180, 219, 220.

[3] Kraeplin: A Measure of Mental Capacity, Pop. Sci. Mo., Vol. XLIX, p. 758.

And yet it should be remarked in passing that the injurious effects of study upon the health of students is in all likelihood due more largely to the unhygienic conditions under which the work is carried on than to mental application itself. It seems to be true that during waking life the mind is constantly active in some direction; and if study could be done under proper conditions, it is probable that it would be no more fatiguing than other sorts of mental occupation. It seems to me it is really not so much a question of the amount of study as of the circumstances under which the study is carried on;[2] except, of course, that if one spends fourteen hours a day over his books he cannot meet the requirements in respect of exercise and sleep discussed above.

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[1] See a summary of six articles on mental fatigue, Psychological Review, Vol. IV, p. 548, *et. seq.* President Elliot recommends his students to spend but eight hours in study. Kellogg, in Good Health for March, 1900, says the old rule of eight hours for work, eight hours for exercise and meals, and eight hours for sleep, is one that ought to be obeyed by every person.

[2] See O'Shea: The Hygiene of School-work; Kindergarten Review, May, 1899.

Looking now at some of the regulations in accordance with which one's study should be prosecuted, it may be seen that one of the most important requisites for economy is the concentration of attention upon any given topic for unbroken periods, differing in length with individuals, with age, and with the nature of the subject attended to. Common-sense tells us that one may accomplish more with less effort when he holds his mind to a task than when it is constantly wandering into by-paths; and neurology has produced some evidence giving warrant to this view. It has pointed out that there is what one might call division of labor in the cerebral factory. In one section is carried forward a certain variety of work, in another a different kind; and so each department has its special duties.[1] Now if one be attending to mathematics, for instance, it is probable that a special department of the brain is particularly active. The memories and the associative functions in that region are aroused and energetic. And the longer one holds his attention to this subject, up to a certain point, the clearer are obscure relations discerned and the more rapidly does thought proceed. In a neurological sense this means that the inertia of the brain in a special area is overcome and energy moves along desired lines with less resistance than at the outset. But now let the attention wander unbidden into another field; it must arouse inactive regions of the brain that for the time being ought to remain dormant. This dissipates both time and vital force.

It must be familiar to every one that solving a problem and learning a poem at the same time is bad economy. So, too, it is a wasteful practice to try to master one's psychology or literature or mathematics while listening to the conversation of a room mate, or while one's mind is idly straying off into neighboring regions of either study or anticipated pleasures. The conservation of mental energy requires that a student should have certain periods when he is wholly uninterrupted and can give his attention absolutely to the task in hand. He should put out of sight and hearing every stimulus which tends to distract attention. One cannot urge too strongly the desirability of fraternities and rooming houses having a rigid law that during certain study periods there shall be a gag on every mouth and a millstone attached to every heel.

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[1] See Donaldson, *op. cit.*, Chapter on *Localization of Function* for an exposition of the theory. The literature of the subject is very extensive and any one interested might consult Flechsig, *op. cit.*; Ferrier, *Localization of Function*. Munk, Horsley, Schäfer, Hitzig, Meynert, Brocca, *et al.*, have written much on the subject.

A large number of our students—over forty per cent.—reported that their study periods are interrupted; some have only a very brief period during which they are certain of being unmolested. Five reported one hour that could be given without interruption to study; twenty-two, two hours; forty-seven, three hours; fifty-four hours; thirty, five hours; twenty-eight, six hours; thirteen, seven hours; five, eight hours; one, nine hours. Engineers have little time that is given uninterruptedly to study aside from their laboratory work. This report indicates a need of reform, for more reasons than one, too. It has already been said that interruption involves waste; but it has an even more serious psychological effect. In order to discover the deeper relationships existing between ideas in any field one must have long periods for reflection. It is to be feared that many of our students do not have leisure to explore the depths of the subject which they study; they simply attach ideas to the mind in a sort of tangential fashion through the exercise of the verbal memory. Reason seems to prosper only in relatively long periods of application, while the mechanical memory may utilize profitably mere snatches of time.

While economy demands uninterrupted periods for study, yet this does not mean that the student should apply himself five or six or seven hours without any relaxation. On the contrary investigations by Burgerstein,[1] Holmes,[2] Kraeplin,[3] and others show that greater progress is made in the intellectual operations if attention be not constrained to a given task beyond the point of fatigue.[4] If at the approach of fatigue the attention be released for a time it will return with renewed vigor and in the long run accomplish more than if it be held continuously regardless of cerebral wear and tear. Efforts have been made to ascertain the span during which attention can be profitably held to a subject; but as in the case of the amount of work which can be done, the result must be purely relative; it depends upon the subject and upon the individual. It is thought by some, though, that in general fatigue intervenes after twenty minutes concentrated effort in the early years and sixty minutes or thereabouts in maturer life.[1] It is probable, however, that a vigorous adult possessing a well organized brain can apply himself to one subject for a longer period than an hour. Experience and the principles of neurology both warrant the hypothesis that energy generated in one part of such a brain may be utilized readily in carrying forward work in other regions.[2] But the association fibers which make possible the easy transmission of energy from one cell to another do not apparently attain their complete development until about the age of thirty-three, as is indicated in Fig. 17.

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[1] Ped. Sem., June, 1892, pp. 60, *et. seq.*

[2] Ped. Sem., Vol. III, pp. 213-234.

[3] *Loc. cit.*

[4] Cf. Newsholme *op. cit.*, p. 66. Also Kotelmann, *School Hygiene*, Chap. XIII.

Now if the assumption be true that the associative fibers serve as energy-carriers between the various cerebral departments, and these fibers are maturing constantly until middle life, then it follows that the Senior in the University should, other things being equal, be able to apply himself with profit for longer periods than the Freshman. But it is certainly impossible in the present state of our knowledge to say just how long should be the study periods of either the Senior or the Freshman. All we are warranted in saying, which is far from as definite as can be desired, is that attention should be concentrated upon a single subject at a time and held to it until the approach of fatigue, when it should be released. If the same study is to be continued, a break of ten minutes passed in moderate physical activities will aid in the removal of worn out materials from the brain and in securing a fresh supply of blood in the cerebrum. It is

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[1] See Ped. Sem., June, 1892, pp. 64 and 63.

[2] Flechsig: *Gehirn und Seele*, presents strong evidence in favor of the view that energy generated in one part of the brain may be put to use in remote regions. See also Curtis: *Inhibition; Ped. Sem.*, Vol. VI, No. 1, for a valuable discussion of the subject.

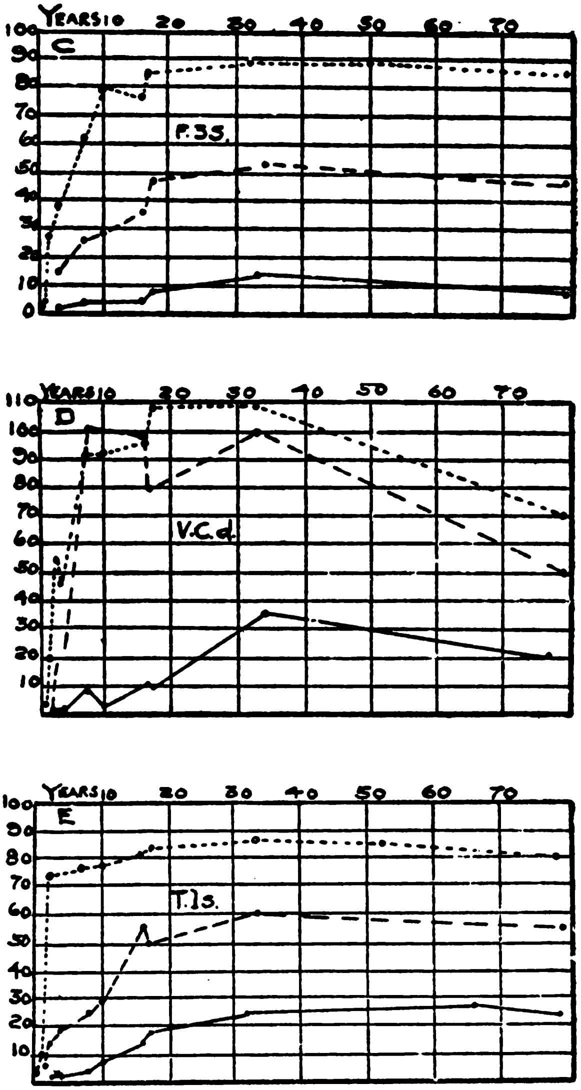

FIG. 17.—Charts showing the increase in the medullated fibres in the three layers of the brain during the growing period and the decrease in advanced age. Birth, to 79 years (modified from Vulpius). C, third frontal gyrus, left side; D, anterior central gyrus, right side; E, first temporal gyrus, left side, ... outer layer; ...., middle layer; ...., inner layer. (Donaldson.)

important, though, that the relaxing exercises should not demand just as great concentration of attention as the study; the purpose in relaxing, which was argued in the preceding chapter, is to relieve the will, to set it free, when it will return with renewed vigor to mental tasks.

The sequence of studies in the day's work is an important subject for the student. The principle governing this matter is dependent upon the neurological fact already discussed, that different regions of the brain have charge of characteristic mental activities. When then the mathematical center has been exercised for a reasonable period, economy would suggest that this be relieved while other areas be employed. To follow one mathematical study by another is not the part of wisdom unless the first has used but a fraction of the available energy. If it were possible it would be advisable to keep the attention concentrated upon a subject, as mathematics or literature, until the energy which can be utilized in that direction is largely spent; then turn to another study of a different character. This is not so important for the mature as for the immature brain-worker; a Senior should be able to disregard the law of sequence in studies with greater impunity than a Freshman. He can draw more largely upon all his resources for special purposes; he can summon most of his strength, totalize it, as it were, on occasion. But yet even with the upper classman prudence would advise arranging the day's program so that studies employing different mental activities should relieve one another. This is especially important in relation to the mental and motor branches. If a student has to prepare three subjects during the day, two of which require much writing and the third none at all, it would doubtless be best for him to put the non-writing subject between the others, so that the cerebral motor regions employed in writing may perform the required tasks without exhaustion.

A student does not have entire option respecting the hours of the day which can be spent in study, but yet the matter is under his own control in some measure. A few of our students have contracted the habit of visiting in the forenoon and studying at midnight, going on the principle that one hour is as good as another for study and the fresh morning hours are the best for social pastimes. But practically all those who reported testified that their minds worked best in the forenoon; eighteen reported being best in the afternoon, while two found they could accomplish more at 5 o'clock in the morning than at any other hour. The best hours ranged from 7 to 12 in the forenoon, while the choicest period of the day is from 9 to 11. These hours accord with investigations made by Lombard, although his results are not by any means conclusive, since too few subjects have been studied and disturbing factors such as the influence of alcohol, tobacco, and food, make his data in a measure unreliable. Still his curve showing the rhythm of daily fatigue is at least suggestive, and may be given here:

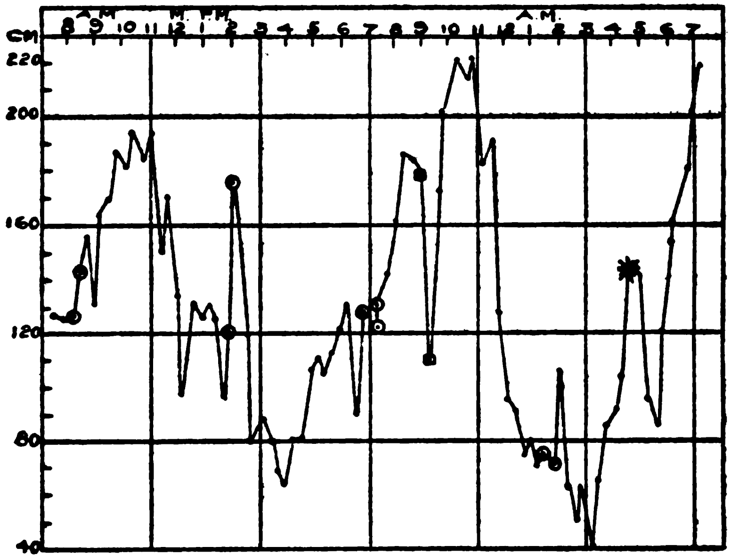

FIG. 18.—Showing at each hour of the day and night how many centimeters a weight of 3,000 grammes could be raised by repeated voluntary contractions of the forefinger before fatigue set in. The curve is highest at 10 to 11 A. M. and 10 to 11 P. M. Lowest 3 to 4 P. M. and 3 to 4 A. M. Circle with dot observation made just after taking food; square with dot smoking;* work done eight minutes after drinking fifteen cubic centimeters of whisky. (Donaldson after Lombard.)

There can be little doubt that for most people the morning hours are the most profitable to be devoted to diligent, concentrated study. The afternoon hours can be employed to greater advantage in duties demanding less energizing of the will; while in an ideal program the evening hours will be spent almost wholly in relaxation. Considering the number of hours our students devote to study they would, it seems, have ample opportunity to accomplish all of their tasks during the day if they would economize in the ways that have been suggested. The arrangement of a program on this basis is very desirable from many points of view, social and otherwise; but one point especially needs to be made here. It is probable that much study late at night results in a disturbance of sleep. Ninety-three students reported that their sleep was greatly disturbed by dreams; and while people who do not study at night dream, still it is certain that intense mental application throws the brains of most people into an excited condition which is inimical to refreshing sleep. People who dream much waste nervous energy; the mind is active but without profitable outcome. For those who dream after night study it would surely be better economy to work intensely during the day and devote the evening to relaxation and social pleasures which will woo Morpheus to their bedsides when the day is over.

The majority of our students do not usually study later into the night than is ordinarily thought to be healthful. Two reported not studying beyond 8 o'clock; forty-four worked until 9 o'clock, one hundred and eighty-seven until 10 o'clock, seventy until 11 o'clock, nine until 12 o'clock, and one until 1 o'clock. One hundred and four students have studied all night on occasion. Eighteen of these said that it did them no harm, while eighty-six felt "bad, sleepy, dull, tired, ragged," and had no ambition to work the following day. Forty of those who studied very late into the night testify that the knowledge they acquired remained with them; fifty-eight said that in the morning it, like the Arab, had folded its tent and silently slipped away.

§3. *Tell me what company you keep and I will tell you what you are.*—Most of us have little appreciated the importance of this old adage, although we see its truthfulness illustrated every day of our lives. We realize that we gradually become like those with whom we associate. I cannot be in the presence of a friend without unconsciously but yet surely incorporating into my own activities his peculiarities of voice, facial expression, carriage, gesture, and so on. The subconscious phase of personality seems to be charged with the responsibility of making the individual like his environment. When he looks upon a face showing constraint of lips and eyes, he tends to reproduce these tensions in his own features; if he listens to a high-pitched, raspy voice, he feels a strain in his own vocal organs. And so it goes, throughout the whole gamut of human activities; people that go together get to act and even look alike![1]

Physiologists in our day are calling attention to the vast importance in human life of this method of suggestion or imitation, whereby we take as copies the people around us and mold ourselves upon them;[2] and it is of especial importance as it relates to the economy of vital forces. When we are in the company of people who are fatigued, who are over-scrupulous, fussy, tense, and constrained in all their expressions, we quickly reproduce their tensions and so waste energy. Most of us instinctively avoid these "bottled lightning" people, these nervous hypochondriacs; the preservation of life demands it. Now, a student cannot always determine the company he keeps, but yet he is in a way master of the situation; and if he be of the type easily suggested to he should above all things avoid living in the same quarters with a neurotic individual, for if he does his forces will steadily run off without profitable issue. To choose a well-poised and well-nerved room-mate is one of the most important undertakings which can engage the attention of a student. If it should be asked, what will become of the neurotics, it must be answered that the law of the survival of the fittest should have its way in student bodies as elsewhere. At any rate it is a sacred duty to conserve against injury from any source the best, whether moral or physical, that has been given to us in human life.

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[1] See for a great many illustrations of this law, Russell: *Imitation and Allied Activities;* Small: The Suggestibility of Children, Ped. Sem., Vol. IV, No. 2; Sidis: *The Psychology of Suggestion,* Parts on Normal Suggestion and Social Suggestion.

[2] See Baldwin, *Mental Development, Methods and Processes,* Chapters VI and IX, X, XI, XII; Vernon Lee and C. A. Thompson: *Beauty and Ugliness,* Contemporary Review, Vol. 72, pp. 544–569, and 669–688; Scripture: *The New Psychology,* pp. 248–261; Wundt: *Human and Animal Psychology,* pp. 323–339.

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ASPECTS OF MENTAL ECONOMY

AN ESSAY IN SOME PHASES OF THE DYNAMICS OF MIND, WITH PARTICULAR OBSERVATIONS UPON STUDENT LIFE IN THE UNIVERSITY OF WISCONSIN

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